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Tri-Service Review of Existing System Embedded Training (ET) Components

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When it is used as an integral part of system design, Embedded Training (ET) offers what appears to be a unique cost-effective training capability. As part of an effort to develop and implement procedures for designing ET, a survey of the ET systems already fielded was conducted, in order to identify the ET system characteristics which could be included in an ET component for an array of systems, missions, and training and operational environments The data gathered during this review will be used in the development of ET design procedures to incorporate lessons learned from earlier ET component developments. Keywords: Training management, [illegible] training [illegible]

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EXECUTIVE SUMMARY

Requirement

The objective of this effort was to systematically examine the Embedded Training (ET) components and the characteristics of ET implementation in a selected set of systems currently operational in the Army, Navy, and Air Force, to explore the manner in which ET components have been developed and employed, and to attempt to derive principles and "lessons learned" which may be of value in providing guidance for the development of future ET components for Army systems.

Approach

Nine systems with ET components, three each from the Army, Navy, and Air Force, were selected to meet a set of criteria developed as part of the effort. Interview protocols and questionnaires for data collection from four classes of personnel believed to possess critical information about the capabilities and development of the systems and their respective ET components were prepared.

Site visits were conducted to units and commands where such personnel were identified for each of the nine systems. At those sites, the systems and their ET components were examined, where possible, and interviews with numerous personnel were conducted. Additional documentation about the systems and their ET components was also gathered when available, to supplement the interview and questionnaire data during analysis.

Analyses concentrated on identifying specified characteristics of the ET components and the systems with which each component was associated, characterizing the training provided by ET, identifying factors associated with the design and development of the ET components, and assessing impacts on the operation and logistics of the systems associated with the presence of the ET components. The results of the direct analyses of data were considered along with anecdotal data gathered during data collection interviews, to identify commonalities across the systems and to attempt to derive general findings that would be of value in developing guidance for future development of ET components.

Findings

Little commonality of actual implementation was found across the nine ET components studied, save that each utilized some sort of input and display device, and was controlled by computers embedded in or strapped onto the prime item systems. Each of the ET components provided principally skill sustainment training by providing task-related stimuli to system operators. A number of the ET components were effectively utilized for team training for operators within the same system, and several were capable of providing stimuli to support coordinated training on dissimilar systems, through tactical communications links. None of the ET components studied were able to support training for maintenance, although that capability was reportedly to be considered for retrofit in some cases.

Training provided by each of the ET components was judged to be of value by the various user groups from whom data was gathered. Each of the ET components had both strong and weak characteristics from training and implementation points of view, but all provided effective training within their limitations. No advanced training support or training management features were incorporated in any of the ET components (not a surprising finding when considering the state of the art at the time each was developed). In all but one of the ET components studied, ET was implemented as system software elements, rather than as separate courseware, able to be updated independently of system software updates.

The presence of ET in the systems studied generally was found to have neutral effects on logistic demands and maintenance requirements. Some indications were found that ET components developed concurrent with the associated prime item systems may have fewer logistic impacts than those added as retrofit capabilities. No particular differences in effectiveness or training support capability were found between ET components wholly integrated into the design of prime item systems vice "strap-on" implementations. The only strap on ET component studied is probably atypical, and there is no basis to conclude that there is any inherent disadvantage to strap-on ET components as opposed to wholly integrated ET.

In general, the ET provided by the components studied was found to be effective and well-accepted by users. A common expression during the interviews was that additional ET capability is desirable and would be utilized to support training in the units where it is available.

Utilization of Findings

The results of this survey will be combined with those of two parallel survey efforts (one of eight Army systems both with and without ET components; the second dealing with technology applications which may have impacts on future ET developments) to derive general guidelines and procedures for the effective design and development of ET components for current and future Army systems.

PREFACE

This report was prepared by Applied Science Associates, Inc. (ASA), Valencia, Pennsylvania, under Contract MDA903-85-C-0078. The chief field investigators and data gatherers were Dr. M. S. Bogner, Mr. C. B. Harris, and Mr. D. L. Shipton.

The authors wish to acknowledge the assistance and cooperation of many individuals who contributed information, reviewed preliminary drafts, and made suggestions for improving this report. From ASA, the authors wish to thank Mr. Shipton and Mr. Harris for their data collection and continued assistance after the data collection. Also, thanks to Mrs. Ruth Ruckdeschel and Mrs. Tammy Mowry for their clerical support, and to Dr. J. L. Ditzian for his guidance.

The support received from the numerous personnel at the various sites visited is greatly appreciated. Their assistance during the data collection and interest in this effort are reflected in the detailed content of the data in this report.

LIST OF ACRONYMS

AAW	Anti-Air Warfare
AAWC	Anti-Air Warfare Coordinator
ACE	Air Combat Evaluator
ACS	Air Control Supervisor
ACTS	Aegis Combat Training System
AD/T	Air Director/Tracker
ADP	Automatic Data Processor
AFB	Air Force Base
AI	Artificial Intelligence
AIC	Air Intercept Controller
ARC	Air Radar Controller
ASA	Applied Science Associates, Inc.
ASAC	Anti-Submarine Warfare Air Controller
ASROC	Anti-Submarine Rocket
ASW	Anti-Submarine Warfare
ASWCS	Anti-Submarine Warfare Control System
ASWCSO	Anti-Submarine Warfare Control System Operator
ATACO	Air Tactical Control Officer
AWACS	Airborne Warning and Control System
BATR	Bullets At Target Range
BVP D/T	Beacon Video Processor Director/Tracker
C&D	Command and Decision
CAI	Computer Assisted Instruction
CAP	Combat Air Patrol
CDS	Combat Direction System
CG	Guided Missile Cruiser
CGI	Computer Generated Imagery
CIC	Combat Information Center
CIWS	Close-In Weapon System

CO	Commanding Officer
CONUS	Continental United States
COR	Contracting Officer's Representative
CRC	Communication Report Center
CRG	Communications Relay Group
CRT	Cathode-Ray Tube
CSC	Combat System Coordinator
CSTS	Combat Simulation Test System
CU	Control Unit
D/TM	Director/Tracker Monitor
DD	Destroyer
DDG	Guided Missile Destroyer
DLS	Decoy Launch System
DMC	Data Management Console
ECCM	Electronic Counter-Countermeasures
ECM	Electronic Countermeasures
ECS	Engagement Control Station
EPC	Engagement Planning Console
ET	Embedded Training
EW	Electronic Warfare
EWCO	Electronic Warfare Console Operator
EWO	Electronic Warfare Officer
EWS	Electronic Warfare Supervisor
FC	Fire Control system operator
FCS	Fire Control System
GCC	Gun Control Console
GCCO	Gun Control Console Operator
GCOC	Gun Control Officer's Console
GFCS	Gun Fire Control System
GFCSS	Gun Fire Control System Supervisor
GMLS	Guided Missile Launching System
HSI	Hi-Tech Systems, Inc.
HUD	Heads-Up Display
IADT	Integrated Automatic Detection and Tracking
IBCC	Improved Battery Control Central
ICC	Information Coordination Central

ICWAR	Improved Continuous-Wave Acquisition Radar
ID	Identification
IDS	Identification Supervisor
IFF	Identification Friend-or-Foe
IFFC	Integrated Flight/Fire Control
IFT	In-Flight Trainer
IHAWK	Improved Hawk Missile System
IHIPIR	Improved High-Power Illuminator Radar
INS	Inertial Navigation System
IPAR	Improved Pulse-Acquisition Radar
IROR	Improved Range-Only Radar
JCS	Joint Chiefs of Staff
JOPS	Joint Operations and Planning System
LCC	Launch Control Console
LCD	Liquid Crystal Display
LCSMM	Life Cycle System Management Model
LED	Light Emitting Diode
MCC	Mission Crew Commander
MEC	Missile Engagement Controller
MFCS	Missile Fire Control System
MSS	Missile System Supervisor
NAS	Naval Air Station
NOSC	Naval Ocean Systems Command
NSWC	Naval Surface Warfare Center
NTDS	Naval Tactical Data System
NTSC	Naval Training Systems Center
NTU	New Threat Update
OBS	On-Board Simulation
OCONUS	Out of Continental United States
ORTS	Operational Readiness Test System
RADIO MON	Radio Monitor
RAM	Random Access Memory
RCO	Radar Control Operator
RCS	Radio Communications System
RIE	Radar Interface Equipment
RIO	Radar Intercept Officer

ROM	Read Only Memory
RSC	Radar Set Console/Radar System Controller
RSCO	AN/SPS-48E Radar Set Control Operator
SAC	Strategic Air Command
SAS	Surveillance and AIMS System
SDC	Situation Display Console (AWACS)
SDC	Signal Data Converter (DDG-993)
SIMAS	Sonar IN-SITU Mode Assessment System
SOR	State of Readiness
SRC	Surface Radar Controller
SSPS	Sonar Signal Processing System
SSTWC	Surface/Strike Warfare Coordinator (DDG-993)
SSWC	Surface/Strike Warfare Coordinator (CG-47)
SURF D/T	Surface Detector/Tracker
SUW	Surface Warfare
SVTT	Surface Vessel Torpedo Tubes
TACTAS	Tactical Towed Array Sonar
TAO	Tactical Action Officer
TCC	Test Control Console
TDT	Target Designator Transmitter
TIC	Tactical Information Coordinator
TPT	Troop Proficiency Trainer
TRADOC	Training & Doctrine Command
TRK SUP	Track Supervisor
TSE	Tactical Signals Exploitation
UBS	Underwater Battery Supervisor
UFCS	Underwater Fire Control System
UHF	Ultra-High Frequency
USAADASCH	U. S. Army Air Defense Artillery School
VHF	Very-High Frequency
VLS	Vertical Launching System
WCC	Weapons Control Console (DDG-993)
WCC	Weapons Control Computer (IHAWK)
WCP	Weapons Control Panel
WCS	Weapons Control System

WDS	Weapons Direction System
WEC	Weapons Engagement Coordinator
WIN	WWMCCS Information Network
WWMCCS	World-Wide Military Command and Control System

SECTION 1

INTRODUCTION

Background

With the increasing complexity of weapon systems and new applications of technology, training requirements for weapon and other systems have increased in both schools and in operational units. With the implementation of new technologies, particularly computers embedded in systems, it has become possible to include a training component within the prime equipment. Training in which the trainee interacts with the actual system controls, displays, and other operational hardware is termed "Embedded Training (ET)."

ET takes place on the actual weapon system. The weapon system is stimulated by an integrated ET component or subsystem, or an external strap-on ET component. Training on the actual weapon system with ET provides realistic training in the actual performance environment. Training realism is often difficult and expensive to implement in a stand-alone training device. ET benefits units by being available at their site, hence providing more efficient, frequent, and cost-effective sustainment training capability, at least.

There have been many attempts by the military to use ET to support unit training requirements. This report presents the data collected on nine weapon systems and their respective ET components. As part of a program to develop system design concepts for ET, sponsored by the Army Research Institute (ARI) for the Behavioral and Social Sciences and the Project Manager for Training Devices (PM TRADE), a review of existing ET components in the three armed services was conducted. Data were collected on the characteristics of the ET components and systems in which they are embedded, as well as experience with using the ET components to gather "lessons learned." The results of this review will feed into the development of guidelines and procedures for ET decision and design, to be utilized in the system acquisition process. This review is a subtask of ET program Task 2 and is a parallel effort to reviews of Army systems with and without ET and of potential technologies for implementing ET in current and future systems.

Purpose

The data presented here and the results of the analysis performed during this review have been used for generating conclusions concerning how to conduct future ET development efforts. The results of this review will feed into the development of guidelines and procedures for the development of ET components in Army systems.

Report Overview

The remainder of this report consists of three major sections and 13 Appendices.

Section 2 explains the approach used in performing this subtask. First, the selection of systems for this review is presented. Next, the development of the data collection forms and the questionnaires is summarized. Finally, data analysis is discussed.

Section 3 presents an overall summary of the nine systems reviewed and the results of the data analysis. The data are derived from the detailed system summaries presented in Appendices A through I, which in turn are derived from the data collection. The summaries are presented mainly by tables that show the characteristics of the various ET components. The results of the data analysis include commonalities and differences among ET components found during the analysis. This section is divided into the following subsections, corresponding to the data collection effort: ET Component Characteristics, ET Training Features, Impact Factors Affecting The Use of ET, and ET Training Functions.

Section 4 presents a discussion of the analysis results in Section 3 in the form of identifying apparent commonalities among the ET components and their implementation. The discussion is based on tentative findings from evaluating the nine ET components. Some recommendations are based on anecdotal and interview comments data which are not presented in Section 3.

Appendices A through I are summaries of the characteristics of the systems and ET components included in the review. Appendices J through M present samples of the questionnaires used during the data collection process.

SECTION 2

APPROACH

System Selection and Data Gathering Approach

An initial list of weapon systems with ET components was used as a point of departure for selecting the systems and ET components that would be used for the review. A set of criteria were developed for selecting ET components for the review. These criteria were developed and applied to ensure that a balanced cross section of ET components from the three services were selected.

The systems in the initial list were evaluated by applying the selection criteria. Based upon this evaluation, several of the systems on the initial list were deleted and new systems that collectively met the criteria were selected. The following systems and ET components were selected for this review.

1. Army Systems:

   a. Patriot Missile System Troop Proficiency Trainer (TPT);

   b. Missile Minder Command and Control System;

   c. Hawk Missile System Radar Signal Simulator (AN/TPQ-29).

2. Air Force Systems:

   a. World-Wide Military Command and Control System (WWMCCS);

   b. F-15 On-Board Simulator (OBS);

   c. E-3A Airborne Warning and Control System (AWACS).

3. Navy Systems:

   a. F-14 In-Flight Trainer (IFT);

   b. CG-47 Class Cruiser Aegis Combat Training System (ACTS);

   c. DDG-993 Class Destroyer Combat Simulation Test System (CSTS).

Data Collection

Questionnaire Development

The initial list of information elements to be collected during the tri-services review is shown below:

1. The types of tasks and skills acquired using the ET component;
2. The type of weapon system;
3. Constraints of the prime equipment;
4. Major hardware of the ET component;
5. Availability of the prime equipment for ET;
6. Types of tasks taught using the ET component (including operational tasks, maintenance tasks, and team tasks);
7. When and how the ET component is used;
8. Time to activate the ET component;
9. Time to disengage the ET component;
10. Types of training performed in the off-line and on-line modes;
11. The types of media and technologies used by the ET components;
12. Similarities/contrasts between the ET and prime equipment input devices;
13. Ability of the ET component to meet local (unit) training requirements;
14. Estimate of the developmental cost of ET;
15. Perceived benefits of the ET component;
16. Perceived problems with the ET component;
17. Attitude of the trainees toward the use of ET;
18. Who maintains the ET software, courseware, and hardware;

19. Estimated downtime of the ET system;

20. Whether having ET increased the parts required for the weapon system;

21. Whether using the ET component prevented the weapon system from performing an operational mission;

22. Is commercially available software used;

23. How the ET component was developed and fabricated;

24. What instructional features the ET component has (i.e., freeze, playback, fast forward, demonstration mode, help facilities, and performance analysis);

25. Whether the ET component is used for sustainment training;

26. Whether negative transfer of training results from using the ET component.

This initial list of data items was used to develop data collection forms and structured interview protocols. Four separate questionnaires were developed, one for use with each of the following classes of personnel: Program Manager, Training Supervisor, Trainee, and Maintenance. Examples of these questionnaires are contained in Appendices J through M. Data collection instruments were developed in such a fashion as to ensure data commonality between this review and the parallel review of Army systems with and without ET components (Strasel, Dyer, Aldrich, and Burroughs, 1986).

Site Visits

At least one site visit was arranged for each ET component selected for the review. At the sites, data collectors interviewed users of the systems and ET components and, when possible, observed the equipment being used. At the end of each site visit, questionnaires were left for the classes of personnel not available for interview. The list below shows the locations of all the site visits and the systems associated with each site visit.

1. U. S. Army Air Defense Artillery School (USAADASCH), Fort Bliss, Texas—Patriot Missile System TPT, Missile Minder Command and Control System, and AN/TPQ-29;

2. 966 AWACS STS/CC, Tinker Air Force Base (AFB), Oklahoma--AWACS;

3. Air Force Wright Aeronautical Laboratories, Wright-Patterson AFB, Ohio--F-15 OBS;

4. Air Training Command, Keesler AFB, Louisiana--WWMCCS;

5. Naval Training Systems Center (NTSC), Orlando, Florida-ACTS and CSTS introduction and overview of ET in the three services;

6. Naval Ocean System Command (NOSC), Point Loma, California--ACTS and CSTS;

7. Naval Surface Warfare Center (NSWC), Dahlgren, Virginia--ACTS and CSTS;

8. Navy Personnel Research and Development Center (NPRDC), Point Loma, California--F-14 IFT;

9. VF-124, Naval Air Station (NAS) Miramar, California--F-14 IFT;

10. NAS Point Mugu, California--F-14 IFT.

Documentation

During the site visits, documents useful for the review effort were identified and, when possible, copies of these documents were obtained. The documents provided a supplement to site visit data in cases when all the required data were not available. A complete list of the documents used during the review is presented in the Bibliography.

Data Analysis

The data items were categorized to aid the data analysis process. The data gathered from documents and site visits were placed in a database management system. The various data items were summarized across the three services and within each service, to identify commonalities and contrasts. The data analysis was conducted in six major steps which are summarized in this subsection.

Evaluate the Design and Development of the ET System

This part of the analysis identified which ET components were developed in parallel with system development and which were added after the initial weapon system had been delivered. How and when the ET component is updated was also determined. The analysts looked for problems associated with the time of ET development as related to the system life cycle.

Determine the ET Component Characteristics

This task involved identifying the characteristics of the major components of each system and which components were used with ET. Components added to implement ET and components not used during ET were also identified. It should be noted that the list of possible components is merely a "menu" used to organize data collection and analysis efforts. It was not expected that all characteristics might be found in any one system reviewed. In fact, given the time frame during which many of the systems were developed, a number of the characteristics and technologies included on the list were not sufficiently mature to have been considered for inclusion in the system or ET component designs. Many of these characteristics, as well as even more advanced ones, may be considered for future ET components. Thus, it was desirable to explore any of the characteristics that might have been included in the systems reviewed. The following component characteristics list was used for this task in the analysis:

1. Output devices and displays:

    a. Color Cathode-Ray Tube (CRT);
    b. Monochrome or B/W CRT;
    c. Liquid Crystal Display (LCD);
    d. Light Emitting Diode (LED);
    e. Printer.

2. Input devices:

    a. Light pen;
    b. Cursor positioning;
    c. Numeric keypad;
    d. Alphanumeric keyboard;
    e. Alphanumeric keypad.

3. Control devices:

    a. Trackball;
    b. Joystick;
    c. Touch screen;
    d. Mouse;
    e. Cue/menu response;
    f. Special-function keys.

4. Storage devices:

    a. Magnetic tape spool (streaming tape);
    b. Magnetic tape cartridge;
    c. Magnetic hard-disk cartridge;
    d. Magnetic floppy disk;
    e. Built-in hard disk;
    f. Video disk;
    g. Slides.

Determine the ET Features

This task involved identifying the various features available as part of the ET components of each system. As with the exploration of characteristics of ET components, not all features were expected to be present in any (or all) of the systems reviewed. For similar reasons, however, highly advanced features were considered in the review to capture any data that might be available. Related features were grouped into manageable categories. The features considered in this part of the analysis are:

1. Computer-Oriented Features:

   a. Computer Assisted Instruction (CAI);
   b. Artificial Intelligence (AI);
   c. Computer Generated Imagery (CGI).

2. Training Management Features:

   a. Adaptive training;
   b. Scenario authoring;
   c. Built-in recordkeeping;
   d. On-line scenario modification.

3. Automated Training Features:

   a. Performance feedback;
   b. Performance recording;
   c. Performance measuring;
   d. Report generation.

4. Scenario Control Features:

   a. Scenario freeze;
   b. Scenario fast-forward;
   c. Scenario playback.

5. Instructional Features:

   a. Demonstration training mode;
   b. User-help facility.

6. ET/System Coordination Features:

   a. Integrated or strap-on;
   b. Off-line capability;
   c. On-line capability;
   d. Collective training.

Determine the Impact Factors Affecting the Use of ET

This task consisted of an analysis of user comments about specific problems encountered at the unit that impacted the use of the ET components. The impact factors were grouped under three major topics. The following impact factors were identified for this task of the analysis:

1. Logistical Impact Factors:

    a. Whether ET increased parts needs;

    b. Whether ET increased maintenance requirements;

    c. Whether using ET increased wear of the weapon system;

    d. Whether ET had significant equipment or operating differences from the weapon system.

2. Time Impact Factors:

    a. Amount of system down time;

    b. Trainee availability;

    c. Equipment availability;

    d. Life cycle phase when the ET component was developed.

3. Operating Impact Factors:

    a. How easy it is to initialize ET;

    b. How easy it is to shut down ET;

    c. How easy it is to operate the weapon system;

    d. How easy it is to operate the ET component;

    e. Time it takes to initiaiize ET;

    f. Time it takes to shut down ET.

ET Training Functions

This task involved itemizing the capabilities of the ET components and determining the functions of the ET in terms of training. The following functions were used for this part of the analysis:

1. Task Categories Trained:

    a. Equipment operation tasks;
    b. Team operation tasks;
    c. Maintenance tasks.

2. Training Uses:

    a. Individual training;
    b. Team training;
    c. Preparatory exercises;
    d. Readiness evaluations.

3. Types of ET Training:

    a. Full-mission-scenario training;
    b. Part-mission-scenario training;
    c. Part-task training.

Determine Objective Categories Trained and Levels of Training

Finally, an attempt was made to identify characteristics of the training provided by the various ET components. This task is based on knowledge about ET gained since the start of the ET research program, inferences about the systems reviewed and their ET components, and the data collected. The other analysis tasks only considered the data as collected. The following training categories and training levels were used for this part of the analysis:

1. Objective Categories:

    a. Basic manipulative skills;
    b. Invariant procedures;
    c. Variable/contingency procedures;
    d. Knowledges;
    e. Rule/concept utilization;
    f. Multiple integrated skills.

2. Training Levels:

    a. Initial;
    b. Sustainment;
    c. Full mastery.

SECTION 3

DATA ANALYSIS RESULTS

An overall view of the nine selected ET components indicates there is a great diversity among ET components within each service and among the services. Each ET component reviewed had some favorable characteristics; however, no two systems were very similar in design. The only characteristics common to all of the ET components were the perceived benefits of ET and the acceptance level of the ET concept (ET is held in high esteem among the weapon systems' users in the three services) and the fact that each ET component used some type of display, input, and control device.

In interpreting the information presented here, the reader should keep in mind the fact that most of the systems and ET components reviewed have been fielded for some time. Thus, they reflect the hardware and software technology state of the art at the time they were developed. Even though the data collection format identified such features as AI and videodisc, these features were absent from all of the systems reviewed.

In this section, a summary of the data collected on the selected ET components is presented, along with the results of data analyses. The analyses performed during this review involved direct analysis of the data collected, application of known human factors and training principles, and the consideration of ET-specific data gathered since the start of the overall ET program. The data analyzed in this section are directly derived from the system data summaries presented in Appendices A through I.

ET Component Characteristics

In general, ET appeared not to have negative impacts upon system operation or person-machine interfaces. Additional equipment beyond that incorporated in the prime system was necessary only in the case of the AN/TPQ-29, which is a strap-on ET component. Training-specific displays and controls in support of ET were incorporated in only one of the systems reviewed—CSTS. The CSTS required the installation on board ship of several general purpose computers and a Test Control Console (TCC) which served as the instructor station. These computers and controls were not used in the operational mode and thus had no direct impact upon system operability.

Generally, the ET components were physically indistinguishable from the remainder of the systems' user-system interfaces. Normal operating controls and displays were used to conduct training via ET in all but one case (AN/TPQ-29), the only strap-on ET component studied.

ET Training Features

Training features are those aspects of a training system (usually hardware or software, although sometimes courseware) that facilitate training or allow learning to occur. In this report these have been subdivided into six categories:

1. Computer-Oriented Features;
2. Training Management Features;
3. Automated Training Features;
4. Scenario Control Features;
5. Instructional Features;
6. ET/System Coordination Features.

Each is discussed separately below.

Computer-Oriented Features

Computer-oriented features are aspects of instruction that can only be incorporated into the training program when there is a computer presenting some or all of the training. These features take advantage of the computer's storage and processing capacity. In this category our investigation assessed three features, any one of which could conceivably have been implemented independent of or along with any other computer feature: Computer Assisted Instruction, Artificial Intelligence, and Computer Generated Imagery.

The only computer-oriented feature found among the nine ET components was CAI. CAI is factual or procedural instruction presented on a computer. The lessons or exercises reside in the computer or in its storage media (e.g., disk, tape, videodisc, slides) and instruction is presented via some presentation media (e.g., video screen, projection, sound speaker).

WWMCCS was the only system that had a CAI capability. CAI was especially appropriate for WWMCCS since this system had multiple consoles. Under ordinary conditions, all of the consoles are not required for operational readiness; thus, some of the consoles are usually available for training. In addition, the physical environment was conducive to CAI training; there was room for texts, note-taking, and over-the-shoulder assistance. WWMCCS CAI was used to present procedural and factual information as well as provide remedial instruction. Although WWMCCS ET incorporates situational simulation capability, this was reported not to be used significantly for training.

Training Management Features

The features in this category are used by training managers and instructors during preparation for the training session or during conduct of training. The features in this category include:

1. Adaptive Training;
2. Scenario Authoring;
3. Built-In Recordkeeping;
4. On-Line Scenario Modification.

Table 1 shows the training management features found in each of the systems reviewed.

Table 1

ET Training Management Features

Service/System	Adaptive Training	Scenario Authoring	Built-In Record-keeping	On-Line Scenario Modification
Army				
Patriot TPT		X		
Missile Minder				
Hawk AN/TPQ-29		X		
Air Force				
WWMCCS	X	X	X	
F-15 OBS				
AWACS		X		X
Navy				
F-14 IFT				
Aegis ACTS		X		X
DDG-993 CSTS		X		X
Group Totals	1	6	1	3

Adaptive Training. Adaptive training is the use of the ET component to adjust the difficulty level of training scenarios or lessons based upon the operator's performance.

WWMCCS was the only system to have adaptive training, which is used only in the CAI mode. Trainees are automatically sent through remedial training modules of instruction when they fail a CAI test. WWMCCS did not have adaptive capabilities in the simulation mode.

Several of the ET components had scenarios with difficulty levels that could be selected by the trainee or instructor prior to starting the scenario. For example, the F-14 IFT has preprogrammed scenarios with assigned difficulty levels. While this is not adaptive training as defined here, it does allow F-14 crewmembers or training managers to select scenarios that are best suited for crews' skill levels and training needs.

Scenario Authoring. Scenario authoring is the capability to create or update scenarios without an equipment software update.

Six of the nine selected ET components had scenario authoring capabilities; the F-14 IFT, Missile Minder, and the F-15 OBS did not. The F-14 IFT does not receive scenario changes unless there is a modification to the weapon system software. The scenarios are stored in Read Only Memory (ROM), which is difficult to update. Missile Minder requires Software Support Center activity to develop, produce, and deliver new training tapes for units. Although the F-15 OBS does not have a scenario authoring capability, it has the storage capacity for a great number of exercises coupled with random selection of exercise presentation.

Among the ET components that have scenario authoring capability, actual authoring occurs at an organizational level above the unit. Adjustments are made at the unit level in order to provide the variability necessary for training personnel in multiple combat environments or scenarios. For example, shipboard systems like Aegis need scenarios that simulate weather and subsurface acoustic conditions for all of the oceans. Scenario authoring is performed at a level above the unit to ensure that all units are provided with standardized and meaningful training. The units provide input related to necessary changes or additions to existing scenarios. WWMCCS training is a useful example of how a system like this works. The WWMCCS training command at Keesler Air Force Base is responsible for producing, refining, and issuing the CAI tapes used by WWMCCS personnel. The test scores of the personnel using the CAI tapes are forwarded to the training command, where they are reviewed and any needed changes to CAI lessons are identified. Revised tapes are then issued to WWMCCS sites. Each WWMCCS site is allowed to create its own CAI tapes but not to alter the issued CAI tapes. This provides unit flexibility while ensuring that the units all have the minimum standard training support necessary.

Built-In Recordkeeping. This feature is used to record trainee performance during training and over successive training sessions.

WWMCCS is the only system studied with a built-in recordkeeping capability. WWMCCS uses training results to determine readiness of the WWMCCS Information Network (WIN). Each WWMCCS unit forwards CAI test results to the WWMCCS training center at Keesler Air Force Base to be used to refine CAI tape presentations.

On-Line Scenario Modification. This feature allows the training manager or instructor to alter a scenario while it is running. In addition, an on-line scenario modification capability makes it possible to produce variable scenario scripts as an alternative or supplement to preprogrammed scenarios.

As indicated in Table 1, three of the nine selected ET components have the capability for on-line scenario modifications. Scripted scenarios can be used for readiness evaluations as well as training. For example, the ACTS ships use scenario modification control to produce a scenario before a readiness evaluation, and run the script via ET during the evaluation.

Automated Training Features

Many training functions normally performed manually can be automated within an ET component. The four automated training features examined during this review are:

1. Performance Feedback;
2. Performance Recording;
3. Performance Measurement;
4. Report Generation.

Table 2 shows the automated training features included in each of the systems reviewed.

Table 2

Automated ET Training Features

Service/System	Performance Feedback	Performance Recording	Performance Measuring	Report Generation
Army				
Patriot TPT				
Missile Minder		X		X
Hawk AN/TPQ-29				
Air Force				
WWMCCS	X	X	X	
F-15 OBS				
AWACS		X		
Navy				
F-14 IFT				
Aegis ACTS		X		X
DDG-993 CSTS				
Group Totals	1	4	1	2

Performance Feedback. Performance feedback can take the form of a message indicating that an incorrect action or decision has taken place during the training session, or as detailed explanation of incorrect operator actions and what the action should have been.

Only WWMCCS has automated performance feedback. This capability is used only in the CAI mode and not during the simulation mode.

Performance Recording. This feature is the extraction of operator performance and scenario dynamics during training. Performance data are stored on a storage medium and later used for scenario replay or reconstruction. This reconstruction can be useful for detailed analysis and feedback to the trainee.

Four of the ET components reviewed have performance recording capabilities. The actual storage medium can be portable (as with AWACS), which allows replay and reconstruction at a designated training-debrief site. If the storage medium is not portable, the recorded data are transmitted to a debrief site or replayed on the actual equipment. All four ET components with performance recording capability replay recorded performance data on the actual equipment as well as at alternate sites.

Performance Measurement. This feature is an actual determination by ET of whether the operator has performed the correct action or has operated the equipment correctly.

Of the systems studied, only WWMCCS ET has automated performance measurement. This capability is used only in the CAI mode and not in the simulation mode. It should be noted that behavioral-level performance measurement, while ideal for many potential ET applications, is only now becoming a viable capability. Hence, its absence in the systems studied is not surprising.

Report Generation. This ET feature provides the training manager with a display or hardcopy printout of the process or results of a training session. The report may consist of raw data for analysis, or the results of the performance measurement. Systems that have only printouts of target data which do not contain any operator performance data (like the Patriot) are not considered to have a report generation capability.

ACTS and Missile Minder are the only systems studied having a performance report generation capability. The reports produced by the ET components are limited to listing successful engagements, number of missed attempts, number of attempts, and other summary data not directly associated with details of trainee performance. Appendix B contains a sample of the Missile Minder report. A sample of the ACTS report was not available.

Scenario Control Features

Scenario control features are aspects of instruction that allow the training manager or instructor to control the training session. These features take advantage of a computer's processing and storage abilities. The features in this category are:

1. Scenario Freeze;
2. Scenario Playback;
3. Scenario Fast-Forward.

Table 3 shows the scenario control features found in each of the systems reviewed.

Table 3

ET Scenario Control Features

Service/System	Scenario Freeze	Scenario Playback	Scenario Fast-Forward
Army			
Patriot TPT			
Missile Minder		X	
Hawk AN/TPQ-29			
Air Force			
WWMCCS			
F-15 OBS			
AWACS	X	X	X
Navy			
F-14 IFT			
Aegis ACTS		X	
DDG-993 CSTS			
Group Totals	1	3	1

Scenario Freeze. This feature has two possible implementations. First, there is manual freeze, which allows the training manager or instructor to interrupt the scenario to assist the trainee. This is a useful tool for the instructor. The freeze allows more interaction between the trainee and instructor, without loss of training time in the scenario. In this way, the trainee can receive guidance and even receive detailed instructions or critique at critical points in a scenario.

The second implementation of this feature is automatic freeze that occurs when a trainee attempts to perform an action that could injure personnel or damage equipment, or which exceeds some established parameters of the training scenario. After freezing the scenario at the point at which an error of this type occurs, an instructor can be called, and an opportunity made to explain the factors associated with the incorrect action. Automatic freeze allows instructors (if any) to perform other duties during training, rather than requiring constant over-the-shoulder observation to catch such occurrences.

Of the systems studied, AWACS has the only ET component capable of freezing a scenario during training and resuming the scenario from the same point.

Scenario Playback. Scenario playback is the capability to provide scenario replay including the actions taken by the trainee in response to the scenario situation and dynamics. Scenario playback can occur on the prime equipment or at a designated training debrief site. In order to replay a scenario in a location other than the prime equipment, it is necessary to record the data on a portable medium or to transmit the data to the other equipment.

Missile Minder ET, AWACS ET, and ACTS each has playback capability; all three are capable of playback on the actual equipment or at a training debriefing site.

Scenario Fast-Forward. This feature serves two functions. First, it enables the instructor or trainee to start a scenario at a point other than the beginning. Second, it is useful during playback for skipping over insignificant or unneeded parts of the scenario. This is useful when a trainee needs to practice particular sequences such as responding to a mass coordinated attack. This feature supports ET for part-scenario training or part-task training.

AWACS is the only system with a scenario fast-forward capability. This capability is used by AWACS crews to enter scenarios at selected points.

Instructional Features

These are features that can assist the trainee or instructor in using the ET component. Two instructional features were considered in this review:

1. Demonstration mode;
2. User-help facility.

These features were not found on any of the nine ET components reviewed.

ET/System Coordination Features

How the ET component is configured and how it relates to the operational equipment are of importance to ET users. The coordination features included in this review are:

1. Whether the ET is a "strap on" or was completely integrated into the prime equipment;

2. Whether ET is used in an on-line or off-line mode;

3. Whether ET supports coordinated training with other similar or dissimilar types of systems.

Table 4 shows the ET/system coordination features found for each of the systems reviewed.

Table 4

ET/System Coordination Features

Service/System	Integrated	Strap-On	Off-Line	On-Line	Coordinated Training
Army					
Patriot TPT	X		X		X
Missile Minder	X		X	X	X
Hawk AN/TPQ-29		X	X		
Air Force					
WWMCCS	X		X	X	X
F-15 OBS	X			X	
AWACS	X		X	X	X
Navy					
F-14 IFT	X			X	
Aegis ACTS	X		X	X	X
DDG-993 CSTS	X		X		
Group Totals	8	1	7	6	5

Integrated/Strap-On. Integrated means that the ET component does not require a separate physical device to be connected to the prime system. An integrated ET component can have independent processors, displays, and controls (as the CSTS does), or it can use processors, controls, and displays of the prime system.

Eight of the ET components were designed as integrated subsystems within the prime equipment. The Hawk missile system was the only weapon system with a strap-on ET component (AN/TPQ-29). There are problems associated with the strap-on nature of the AN/TPQ-29. The most significant problems are related to the time required to hook up and remove the strap-on component. In this case, the strap-on component was reported to have the benefit of being less costly than adding an integral ET component, after the weapon system had been deployed.

Off-Line Training. During off-line training, the prime equipment is removed from operational use while training is conducted.

Seven of the ET components are capable of training in an off-line mode. It appears to be a useful mode, as long as the actual equipment is available for off-line training. However, some weapon systems reviewed have such high readiness requirements that prime equipment is not available for off-line training. When State of Readiness (SOR) requirements prohibit the use of the equipment in an off-line mode, an on-line component may be necessary.

On-Line Training. During this type of training, the weapon system is able to perform its operational mission while training is conducted. Three methods have been identified for conducting on-line training. The first method is used when there is more than one operator station. Selected stations are used for training while the other stations are used for performing operational duties. A second way to conduct on-line training is to have simulated targets or other stimuli overlaying the operational environment. The third method is to employ an "automatic alert" system that stops the training session and automatically reconfigures the weapon system to an operational mode when certain conditions are met.

Six of the ET components reviewed are capable of providing on-line training. WWMCCS and ACTS use multiple operator stations; during on-line training one or more stations are used for training, while operational duties are performed at other stations. AWACS is the only ET component reviewed that has an "automatic shutoff" capability to suspend training when specified conditions were met. No ET component reviewed uses a combination of simulation and actual operational utilization ("simulated over live").

Coordinated Training. Training with other weapon systems and units is coordinated training. The method used for coordinated training by the ET components reviewed is to send simulated targets to other weapon systems over a communications link.

Five of the weapon systems reviewed have the capability to provide simulated targets for other weapon systems. The ET components use communications links to send targets to other systems, to allow operators of separate weapon systems to interact, and to coordinate exercises with other units. This allows several weapon systems to train against the same targets at the same time. In addition, these five weapon systems are capable of providing simulated targets for physically separated units of the same weapon system. Coordinated training appears to be useful for training personnel who are responsible for coordinating multiple weapon systems during a mission. This type of training is especially applicable to command, control, and communication systems, since their mission is to coordinate multiple weapon systems. AWACS and Missile Minder are examples of such systems.

Impact Factors Affecting the Use of ET

Logistical Impact Factors

ET can have an impact on the logistics of a system. Such effects can contribute to both positive and negative attitudes toward ET and the use of ET. The categories impacts evaluated are:

1. Effects on equipment differences;
2. Effects on parts requirements;
3. Effects on maintenance requirements;
4. Effects on equipment wear.

The presence of ET has reported negative logistical impacts on only two of the systems studied; Hawk used with AN/TPQ-29, and DDG-993 CSTS. In this section, the logistical impact factors affecting the use of these two systems is discussed.

Logistical Impact Factors Affecting the Use of the Hawk With AN/TPQ-29. The AN/TPQ-29 is a strap-on ET component with many unique parts and operating characteristics. Introducing this device is reported to have resulted in an increase in the number of parts required in inventory, in maintenance requirements, and in additional training needed due to equipment uniqueness. The difficulties encountered during hooking up the AN/TPQ-29 have increased wear on Hawk prime system components. The major problem is reported to be with personnel bending cannon plug pins when hooking up the AN/TPQ-29. The damaged plugs must be replaced before a Hawk weapon system can again be connected to the AN/TPQ-29.

Logistical Impact Factors Affecting the Use of the DDG-993 CSTS. The CSTS is a former strap-on component that was integrated into the DDG-993 ships. The unique equipment and operating characteristics of the CSTS are reported to have increased the number of parts that must be carried in the ship's inventory. The presence of the CSTS has also reportedly increased maintenance requirements for the ship overall. Equipment differences have had no significant negative impacts on training requirements for the ships' crews, since CSTS is menu-driven and very user-friendly. The CSTS was developed specifically to relieve the schools of personnel-replacement requirements they were not capable of meeting.

Time Impact Factors

The four time impact factors examined during the review are:

1. Overall System Downtime;
2. Availability of Trainees for Training;
3. Availability of Equipment for Training;
4. Life-Cycle Phase During Which the ET Component was Developed.

Table 5 shows the time impact factor ratings for each of the weapon systems.

Table 5

ET Time Impact Factors

Service/System	System Downtime	Trainee Availability	Equipment Availability	Time of Development
Army				
Patriot TPT	L	A	A	B
Missile Minder	L	I	I	B
Hawk AN/TPQ-29	H	I	I	F
Air Force				
WWMCCS	L	A	A	F
F-15 OBS	L	A	A	F
AWACS	L	S	S	B
Navy				
F-14 IFT	L	A	A	B
Aegis ACTS	L	A	A	B
DDG-993 CSTS	L	A	A	F
Group Totals	L=8 H=1	I=2 S=1 A=6	I=2 S=1 A=6	F=4 B=5

Table Codes:

L Low, infrequent or no equipment failures
M Moderate, frequent equipment failures.
H High, consistently failing equipment.
A Always available (no restrictions).
S Sometimes available (at least once a week).
I Infrequently available (less than 3 times per month).
B Before initial weapon system delivery.
F Following initial weapons system delivery.

Overall System Downtime. Documents reviewed indicate that AN/TPQ-29 has had a long-standing maintainability problem. There are long periods of downtime, when the equipment is undergoing repair instead of being used for ET. All of the other systems surveyed have low equipment failure rates. A low failure rate means that the equipment is normally ready to present ET, within the constraints of operational and personnel requirements.

Availability of the Trainees and Equipment for Training. In six of the nine systems reviewed, personnel and equipment are scheduled for training (or train with a non-scheduled frequency of) at least once a week. AWACS personnel and equipment are slightly restricted in using ET, due to readiness requirements and flight demands of AWACS units. Missile Minder and Hawk personnel and equipment are restricted even more by the SOR requirements of the units. However, Missile Minder ET cannot be run in the on-line mode, since ET-generated targets enter the communications net, and may be perceived by the Communication Report Center (CRC) as real targets.

Life-Cycle Phase During Which the ET Component was Developed. The life-cycle phase in which ET is developed can have a significant impact on the characteristics and value of the ET component.

Among the systems reviewed, the ET component was developed following initial delivery for four of the systems: AN/TPQ-29, WWMCCS, F-15 OBS, and DDG-993 CSTS. For the remaining five systems, ET was developed concurrently with prime system development. In the following paragraphs, the effects of ET development before and after weapon system delivery are discussed.

Four of the ET components studied were developed after the prime system had been initially delivered. The development of an ET component after system delivery does not necessarily result in an ineffective training element, but appears to increase the cost of the ET component. Although specific data on segregated costs of ET components was not available, examination of the development of the ET components and the changes undergone reveals some possible links to higher ET costs associated with post-fielding with development of ET. Another possible impact of post-fielding development is that ET may have to be designed as a strap-on component.

The AN/TPQ-29 was developed about ten years after the Hawk missile system was first delivered. The main factors (weapon system reliability and SOR requirements) affecting the use of the AN/TPQ-29 do not appear to be direct results of late development. It is not clear whether the AN/TPQ-29 was designed as a strap-on component because of its late development, but if that is the case, the difficulties associated with the hookup of ET, which cause many problems, may be related to the late development of ET, as well as to poor design.

The DDG-993 CSTS was developed in two stages. In its first stage, it was called the Combat System Test Set, and was a strap-on pier-side training and testing device. The first-generation CSTS provided effective training, but it was not considered a practical trainer because it took a full day to set up and check out the device and several hours to disconnect. The second generation, now called the Combat Simulation Test System, has many improved and added capabilities. The biggest improvement is that it is integrated into the ship, requiring no hookup and less setup. Although no specific cost data are available on the CSTS, it appears that adding an ET component in this fashion is costlier than designing it as an integrated component during earlier stages of the life cycle. The CSTS appears to be a satisfactory ET component, but development costs associated with retrofit of the second generation CSTS are reported to have been high. It should be noted that the Navy was forced to purchase the DDG-993 class destroyers after an aborted Foreign Military Sale (to Iran), which is why the CSTS was developed in this manner.

There were no problems reported to be associated with the WWMCCS ET component resulting from its stage of development. Since WWMCCS ET is completely a software implementation, this is not particularly surprising. It is not possible to evaluate the impact of the phase of development of the F-15 OBS, because it is not deployed in active squadrons.

The remaining five ET components evaluated during this review were all developed in parallel with the prime equipment. The main benefit of this approach appears to be that all are integrated ET components. The lack of ET decision and design models is apparent, because none of the ET components of these systems fully train any tasks; however, school training is fully structured, and training devices have been developed to support hands-on training for each of the systems. The training data from the schools and stand-alone training devices was reportedly not utilized for the design of any of the ET components. Apparently, ET design and development was left entirely to system engineers, with few significant inputs from training specialists.

Operating Impact Factors

The operability of a system's ET component and of the system itself can have an impact on the use of ET. The operating impact factors examined in the review are:

1. Ease of Start-up and Shut Down;
2. Overall System Operating Ease;
3. Overall ET Component Operating Ease;
4. Relative Length of Start-up or Shut Down for the ET.

Table 6 shows the operating impact factor ratings for each of the weapon systems reviewed.

Table 6

Operating Impact Factors

Service/System	ET Start-up Ease	ET Shut Down Ease	System Oper. Ease	ET Oper. Ease	ET Start-up Time	ET Shut Down Time
Army						
Patriot TPT	E	E	E	E	L	L
Missile Minder	E	E	E	E	L	L
Hawk AN/TPQ-29	D	D	O	O	H	H
Air Force						
WWMCCS	E	E	E	E	L	L
F-15 OBS	E	E	D	E	L	L
AWACS	E	E	O	E	H	L
Navy						
F-14 IFT	O	E	D	E	L	L
Aegis ACTS	E	E	O	E	M	L
DDG-993 CSTS	O	O	O	E	M	M
Group Totals	E=6 O=2 D=1	E=7 O=1 D=1	E=3 O=4 D=2	E=8 O=1	L=5 M=2 H=2	L=7 M=2 H=1

Table Codes:

E Easy to operate
O Moderately difficult to operate
D Difficult to operate

L Low time to start up or shut down
M Medium time to start up or shut down
H High time to start up or shut down

Ease of Start-up and Shut Down. Start-up and shut down time is the time to load and configure ET and the time to go from the ET mode to the operational mode, respectively.

Six of the ET components were rated as easy to start-up, since start-up required only one switch action and no data entry. Two ET components were rated "medium" in start-up ease because they required more than one switch action and some minimal data entry. The AN/TPQ-29 is considered difficult to start-up, because hooking up the ET component to the Hawk system is difficult and because the Hawk system itself must be set up before the AN/TPQ-29 can be used.

The difficulty of shutting down the ET component was almost always the same as the difficulty of start-up; however, shut down seldom requires data entry. The CSTS was given a "medium" rating for shut down ease because it has many mode switches: one at the TCC and one at each station simulated by the CSTS. The AN/TPQ-29 was rated difficult to shut down because it is as difficult to disengage the AN/TPQ-29 from the Hawk system as it is to engage it. The Hawk equipment also must be retuned and adjusted after the AN/TPQ-29 has been used.

Overall System Operating Ease. The system operating ease rating depends on the system's sophistication, training requirements, and user-friendliness. Three systems were rated as relatively easy to operate, because of their cue/menu responses and automated data processing made the system easy to learn and operate. Four systems required additional training to utilize ET and placed additional demands on the operators. Thus, they were given "moderately difficult" operating-ease ratings. The F-15 and F-14 were considered difficult to operate, since it takes extensive training to prepare crews to operate these systems.

Overall ET Component Operating Ease. When it came to the ease of operating the ET component, only the AN/TPQ-29 was rated as difficult to operate. The AN/TPQ-29 ET component has displays and controls that are substantially different from those of the prime system. This results in additional training requirements. A lack of user-friendliness in the human-system interface reportedly further increased the difficulty of using AN/TPQ-29 ET. All of the other ET components were rated as easy to operate, with user-friendly cues, alerts, and menus.

Relative Length of Start-up or Shut Down for the ET. The ET start-up time is not critical to mission readiness, but does have an impact on the use of ET. Five of the systems have short start-up times, requiring one minute or less to initialize ET. Two systems have moderate start-up times requiring more than one minute, but less than five minutes to initialize ET. Two systems have high start-up times, requiring five minutes or more to initialize ET.

ET shut down time is critical to mission readiness, since when a unit is called upon to fulfill an operational requirement, its response time may be critical to the successful completion of a mission. If an operational need arises while the unit is engaged in ET, the faster the unit can switch from an ET mode to an operational mode, the quicker their response time will be.

Seven systems have ET shut down times of one minute or less. AWACS is the only system with an automatic ET shut down. The DDG-993 CSTS is the only system with a "medium" time (less than five minutes, but more than one minute) for ET shut down. The AN/TPQ-29 is the only system with a long ET shut down time.

ET Training Functions

Task Categories Trained

Training in three task categories was examined during the review: equipment operation tasks, team operation tasks, and maintenance tasks.

Table 7 shows the task categories trained in the systems that were reviewed.

Table 7

Task Categories Trained

Service/System	Equipment Operation Tasks	Team Operation Tasks	Maintenance Tasks
Army			
Patriot TPT	X	X	
Missile Minder	X	X	
Hawk AN/TPQ-29	X	X	
Air Force			
WWMCCS	X	X	
F-15 OBS	X		
AWACS	X	X	
Navy			
F-14 IFT	X	X	
Aegis ACTS	X	X	
DDG-993 CSTS	X	X	
Group Totals	9	8	0

Equipment Operation Tasks. In equipment operation tasks, operators are required to respond to stimuli presented by ET as they would during actual operational use of the equipment.

All nine of the ET components reviewed are used to train equipment operation tasks.

Team Operation Tasks. In team tasks, stimuli are presented that require interaction between two or more operators on the same weapon system or between two or more operators on separate weapon systems. ET is used to provide training that requires the operators to interact effectively in order to successfully complete the mission.

Eight of the ET components reviewed are capable of training team tasks. The F-15 OBS is the only system that cannot train team tasks. This is due to the fact that the system is not capable of providing simulated targets for other aircraft or for ground forces, and because other aircraft are not allowed in the same training airspace with an aircraft using the OBS (to prevent possible collisions during maneuvers).

The Aegis defense system and the combat system on the DDG-993 class destroyer are both large systems that require coordination of weapon systems with multiple operator stations. The ET on these systems provides training in those aspects of team operator performance. Only the AWACS, Aegis, and Missile Minder ET components are used for team training with other (dissimilar) systems.

Maintenance Tasks. None of the systems' ET components currently train maintenance tasks. However, the addition of this capability is reportedly planned for several ET components.

Training Uses

The four training uses of ET examined during the review are:

1. Individual Training;
2. Team Training;
3. Preparatory Exercises;
4. Readiness Evaluations.

In general, the way in which the units use ET appeared to be limited more by the command's desired use of ET than by the capabilities of the ET component. Table 8 shows the training uses of each of the ET components.

Table 8

Training Uses of ET

Service/System	Individual Training	Team Training	Preparatory Exercises	Readiness Evaluation
Army				
Patriot TPT	X	X	X	
Missile Minder		X	X	X
Hawk AN/TPQ-29	X	X		
Air Force				
WWMCCS	X	X		X
F-15 OBS	X			
AWACS	X	X	X	
Navy				
F-14 IFT	X	X	X	
Aegis ACTS	X	X	X	X
DDG-993 CSTS	X	X	X	
Group Totals	8	8	6	3

Individual Training. Eight of the ET components are used for individual training in which one operator is trained alone. Missile Minder ET is the only ET component that was not used for individual training, although it has this capability.

Team Training. Eight of the ET components are used for team training. As mentioned above, only the F-15 OBS is not used for team training.

An example of the usefulness of team training comes from the CG-47 (Aegis) class cruisers. Aegis is a highly sophisticated system, with an array of sensors operated by numerous personnel with different occupational specialties. ACTS supports the training of team tasks for the various sonar, radar, and weapon control station operators by providing simulated air, surface, and subsurface targets. ACTS can also transmit simulated targets to other participating units, such as helicopters or other ships, so that Aegis operators can practice coordinating target prosecution.

Preparatory Exercises. Preparatory exercises are normally large-scale exercises scheduled prior to readiness inspections.

Six of the ET components are used in preparatory exercises. In fact, preparatory exercises are a major use of Missile Minder ET.

Readiness Evaluations. Readiness evaluations are planned exercises that are conducted to evaluate unit readiness.

As shown in Table 8, only three of the ET components reviewed are used during readiness evaluations.

Types of ET Training

The three types of training examined during the review were:

1. Full Mission Scenario;
2. Part Mission Scenario;
3. Part-Task Training.

Table 9 shows the types of ET training conducted on each of the ET components reviewed.

Table 9

Types of ET Training

Service/System	Full Mission Scenario Training	Part Mission Scenario Training	Part-Task Training
Army			
Patriot TPT	X	X	
Missile Minder	X	X	
Hawk AN/TPQ-29	X	X	
Air Force			
WWMCCS	X		X
F-15 OBS		X	
AWACS	X	X	
Navy			
F-14 IFT		X	
Aegis ACTS	X	X	
DDG-993 CSTS	X	X	
Group Totals	7	8	1

Full Mission Scenario. ET provides full mission scenario training by stimulating the equipment for all tasks performed during a mission or evolution.

Full mission scenario training is provided by seven of the ET components reviewed.

Part Mission Scenario. The ET components reviewed provided part scenario training by simulating the equipment for part of the tasks required for successful mission accomplishment.

Eight of the ET components provide part mission scenario training. This type of training is used when there is not enough time to run full mission scenarios, or when operators require training in a specific part of a mission. ET accommodates this type of training wi^h on-line scenario modification or scenario fast-forward features. T' . of the ET components (F-14 IFT and F-15 OBS) are only capable of training part-tasks, because they use preprogrammed scenari. 'hich are not modifiable to incorporate all mission tasks. The F-14 IFT ... .ly capable of training missile firing tasks, and the F-15 OBS can only train aerial gunnery and ground attack tasks.

Part-Task Training. This type of training includes training of only particular tasks or parts of tasks.

WWMCCS CAI is the only ET component reviewed that specifically provides this type of training. Part-task training on WWMCCS CAI is limited to task knowledges rather than actual skills. Part-task training is usually thought of as a part of initial skills acquisition. Thus, it is not commonly conducted at the unit level. It was not therefore surprising that only one of the ET components in this review provides this type of training.

Objective Categories Trained

An analysis of the training objectives provided by each of the ET components was not possible.

Levels of Training

Training objectives have prescribed conditions and standards that state how they should be trained and to what degree they should be trained. The standard, or performance level, of an objective is usually the minimum acceptable level of performance. The training levels considered during analysis include:

1. Skill Acquisition Training;
2. Sustainment Training;
3. Full Mastery Training.

Table 10 shows the training levels for each of the ET components reviewed.

Table 10

Training Levels for ET

Service/System	Skill Acquisition Training	Sustainment Training	Full Mastery Training
Army			
Patriot TPT		X	
Missile Minder		X	
Hawk AN/TPQ-29	X	X	
Air Force			
WWMCCS	X	X	
F-15 OBS		X	
AWACS		X	X
Navy			
F-14 IFT		X	
Aegis ACTS	X	X	X
DDG-993 CSTS	X	X	
Group Totals	4	9	2

Skill Acquisition Training. Acquisition training is used to acquire completely new skills and knowledge.

ET is not commonly used for initial training among the ET components reviewed. WWMCCS is used for training new knowledges, but is not used to train skills. The AN/TPQ-29, ACTS, and CSTS are used to train some new skills only in cases when needed to redress inadequacies in school training.

Sustainment Training. This type of training is used to maintain perishable, critical skills and knowledges at criterion performance level, after initial skill acquisition.

All of the ET components reviewed provide sustainment training. In fact, sustainment training is the principal use of the nine ET components.

Full Mastery Training. In full mastery training, personnel are trained to a level that exceeds the minimum criterion level of performance. This type of training enables acceptably proficient operators to become expert operators, and provides those already expert with opportunities to sharpen their skills.

AWACS and ACTS are the only ET components reviewed that are capable of full mastery training. With ACTS, this capability is utilized to upgrade the skills of already proficient personnel. Although AWACS has this capability, it is seldom used, due to mission performance requirements in flight.

SECTION 4

DISCUSSION

The data presented in Section 3 of this report were further considered, along with anecdotal and interview data from the data collection effort, to attempt to derive general findings which may serve as lessons learned or indications for development of future ET components. This section discusses such general findings that follow from the data. Five general topics are discussed here. They are:

1. General Observations on Embedded Training;

2. ET Development and the System Development Process;

3. ET Utilization and Relationships with System Constraints;

4. Training Characteristics and ET; and

5. ET Interactions with Logistics.

General Observations on Embedded Training

The available data, especially anecdotal data from interviews, strongly suggest that the training provided by the nine ET components examined in this study was perceived as of value. While each of the ET components had both strong and weak characteristics, each also provided training which was clearly needed, and which might have been more difficult to obtain in other fashions than ET. The ET components studied are generally used in a relatively systematic fashion to provide task practice for which each component is suitable. There is no programmatic indication that any of the ET components was a "nice to have" feature of the system (with the possible exception of the F-15 OBS, which is not a deployed system component). However, there is little indication that any of the ET components is responsive to a thoroughly worked-out set of training requirements. Likewise, there is no specific indication that any of the ET components was designed in the context of a "total training system" supporting the prime item system with which each is associated.

The ET components studied almost universally lack modern, advanced training support and training management characteristics commonly associated with state of the art training devices and computer-based training. Given the time at which each of the ET components was developed, and the fact that the ET components appear to have been considered separate from the total training system approach, this finding is not surprising. Even without these advanced features, however, the ET components are able to provide at least some level of effective stimulation to support task practice. This suggests that even ET components of very low levels of sophistication can provide some needed training as an alternative to other approaches.

Especially in cases where dedicated training devices are unavailable or difficult to access by unit-level personnel, "something is better than nothing." Given the probable complexities and potentially high costs of incorporating highly advanced training support capabilities in developing systems or as part of system retrofits, it may be quite acceptable to provide ET capabilities which are not "state of the art," in future efforts to develop systems incorporating ET. Where advanced, sophisticated capabilities are useful or necessary to support training, these should obviously be seriously considered for inclusion in ET components. However, ET should be considered as part of the total training system, and not in isolation from other training elements such as mission simulators, part-task training devices, Conduct-of-Fire Trainers (COFTs), and traditional training approaches.

ET Development and the System Development Process

As discussed earlier, ET components may be developed concurrent with the prime item system, or they may be developed after the prime item system is fielded. Of the systems studied in this effort, the ET components of five were developed concurrently with their associated prime item systems, while ET capabilities were added to fielded systems in four cases. Both cases have generally resulted in ET that trains in an effective manner, within its limitations. There is no indication in the data that development of ET capabilities concurrent with prime item systems results in training which is in any sense "better" than that provided by retrofit ET components. However, in all the cases studied, the training provided by ET was of limited scope. None of the ET components was capable of full-task training, although the ACTS and AWACS ET components came near to this capability with their ability to provide concurrent team-oriented training for multiple operator positions. Even in these cases, there were limitations imposed on the scope of training due to other factors. These are discussed later in this section.

It is interesting to note that the only ET components reported to have integration or reliability problems when used with their prime systems are retrofit components (AN/TPQ-29 and CSTS). This suggests that there may be some inherent advantage to concurrent design and development of ET components and the prime systems in which they are embedded. From the viewpoint of requirements integration and system design, it would appear to be a more efficient and effective practice to anticipate the need for ET at the time system requirements are established, and develop the ET capability concurrent with other prime system capabilities. Anecdotal data gathered during this study tend to support this assertion. This will probably not be possible in all cases, however. As was the case with some of the retrofit ET components studied in this effort (AN/TPQ-29 and WWMCCS CAI), requirements for ET capabilities may surface only after a system has been fielded, and experience with the system has accumulated. There may also be future "opportunity" developments of ET, as was the case with the F-15 OBS. This ET component originated as an acceptance test device for some of the F-15 avionics. The test device's capability to dynamically display information on a Heads-Up Display (HUD) was noted, and the potential for providing stimulation for practice of some mission tasks was subsequently explored.

Another interesting observation derived from the data is that the ET components studied do not appear to be well-coordinated with total training system requirements. Anecdotal reports indicate that there was little, if any, systematic consideration of ET as a component of the total training system supporting any of the systems which were studied. Further supporting this point is the fact that no explicit information concerning training objectives supported nor any of the typical Instructional Systems Development (ISD) audit trail data were obtainable for any of the ET components addressed in the effort. Also, while ET for these systems is generally perceived as beneficial and well-liked by its users, interview data gives the impression that the capability to provide more training via ET than is currently possible would be welcomed.

A speculative conclusion from these data is that the training provided by the ET components studied was not systematically developed to support explicit training requirements. This points up a need in future consideration of ET to treat the ET component as one portion of the total training system, and to ensure that it receives consideration equivalent to (for example) stand-alone training devices as a means to support established training requirements. Clearly, there should not be ET when ET is not needed or where training requirements can be satisfied in more cost-effective ways. ET, however, must also be considered as a component of the overall hardware and software system during initial concept development and design, to insure effective integration of the ET component with the balance of the system. This implies that a means of considering both ET and the total training system must be implemented, coordinated with overall system development. Explicit guidance for identifying both the role of ET as a component of the prime item system and as a component of the total training system will be required to ensure such consideration.

ET Utilization and Relationships with System Constraints

A broad variety of means of utilizing ET in conjunction with the prime item systems was found in the systems studied. Utilization ranged from completely off-line training found in AN/TPQ-29-Hawk ET to the capability to train very nearly concurrent with system operations noted with AWACS ET. The implementation and use of the ET component appears to be partially determined by system SOR requirements. Where SOR requirements are high (e.g., practically instantaneous mission capability must be maintained on a continuous basis), the prime system cannot be taken completely off-line in order to conduct training via ET. Where this was found to be the case in the systems studied (Patriot TPT, AWACS, CSTS, ACTS, and WWMCCS), multiple operator stations were typically available. In each case, one or more operator stations could be taken off-line to provide training, while other stations continued in use to meet mission requirements. In cases where this does not compromise system capabilities or readiness to any significant extent, the ability to conduct concurrent operations and training appears to be an ideal implementation of the ET capability.

For systems with lower SOR requirements on a system-by-system basis, it is sometimes feasible to "down" systems at certain times in order to conduct training. This was found to be acceptable with Missile Minder ET and (to a certain extent) with AN/TPQ-29. Missile Minder ET has the capability to be used in an on-line fashion, but is typically not so used, due to the risk of ET-generated "targets" being broadcast over command and control networks and misinterpreted as "live" targets. This possibility was found to be unacceptable in practice. Utilization of the AN/TPQ-29 with Hawk systems demands that the Hawk systems be taken off-line, since the radar components must be de-tuned from operational status to be utilized with the AN/TPQ-29, and accessory connections made to the ET component hardware. This process essentially renders the Hawk system used with the AN/TPQ-29 non-mission-capable, since the radar is not within normal operational parameters.

The remaining two ET components, F-14 IFT and F-15 OBS, are utilized in an off-line mode, when an aircraft is dedicated for training use (F-15 OBS) or in transit in a non-tactical environment (F-14 IFT). The use of ET in the tactical aircraft systems studied provides some noteworthy benefits. With both ET components, practice of mission-critical tasks in-flight is possible without the need for dedicated target or aggressor aircraft, range instrumentation, or other external support which is often difficult to arrange or costly to obtain. In both cases, the principal constraint on utilization of the ET components is sufficient clear airspace to permit maneuvering for task practice. This suggests that such implementations of ET can provide opportunities for deployed or simply squadron-assigned aircrews to maintain significant proficiency in many mission tasks without the need to access remote range facilities or instrumentation, at little more than the cost of aircraft flight hours. Given the high combat readiness requirements of tactical aircrews and existing airspace and maneuvering restrictions, this could prove to be a "force multiplier" of some magnitude.

ET Utilization and Impacts

In general, the systems with which the ET components are associated and the manner of use of the systems (at least during peacetime) provide sufficient opportunity for use of the ET capabilities to train operators or crewmembers. This is true even though the actual use of the ET components may be difficult (as with the AN/TPQ-29) or may not provide the total range of training which might be desirable in an ideal case. The ET components studied appear in general to add little in the way of logistic or maintenance burden to their associated systems, especially in the cases where ET components were designed concurrent with the prime system and are wholly integrated in prime system design. This may be a false conclusion, however, as it would be most difficult to segregate operational or logistic impacts of a wholly integrated ET component from similar characteristics of the systems in which they are embedded. Such data were not available to the study team during the course of the review.

During the review, it was noted that no use was made (or could be made) of the various ET components to support training for maintenance of the systems studied. Anecdotal reports gathered during the interviews suggest that the capability to support some maintenance training for some of the systems was being considered as a retrofit to ET components. It is speculated that the most valuable use of an ET component for maintenance training would be to support the development of troubleshooting and diagnostic fault isolation skills for complex systems. These are skills which are scarce and difficult to build, since fault and symptom patterns for some critical maintenance problems occur seldom, providing scant opportunity for the maintainer to learn to recognize such stimuli. Also, the infra-skills and reasoning patterns of maintenance fault isolation are difficult to train without numerous examples of symptom patterns. ET may provide a useful and convenient means of building and sustaining such skills for future systems, at relatively low cost.

Training Characteristics and ET

During this study, a number of training-related features were sought in the ET components studied. Practically none of the ET components incorporate the more advanced training presentation or support features which were looked for, yet all train more or less effectively. This finding more or less contradicts an implicit assumption that such advanced features are necessary in order to have "good" ET. While the training provided by the various ET components that were studied generally falls short of the trainer's ideal model of a training system (including performance assessment and feedback related to specific training objectives and task behaviors), each of the ET components does provide needed task practice for system operators. This is perceived as a significant benefit by units using the ET components, as well as by higher-level organizational elements.

Types of Training Provided by ET

Three distinct types of training were observed in the ET components studied: individual training; team training involving multiple personnel performing similar or different tasks on the same system; and coordinated training involving multiple systems of similar or dissimilar types. The majority of individual training found was part-mission task proficiency training. Such training is particularly useful for developing or sustaining critical portions of individual task responsibilities without the necessity to practice all mission tasks. Most individual training was used for skill sustainment; in only one case (CSTS) was individual skill acquisition training emphasized. This was reportedly due to skill deficiencies in personnel arriving from shore-based schools. The need for school training to support skill development for the DDG-993 class ("Ayatollah class") guided missile destroyers was not anticipated for U.S. Navy personnel, since the ships were originally purchased by Iran, and no similar ships were programmed for Navy acquisition. While such situations are not common, this may indicate a role for some future ET components: compensating for deficiencies in other aspects of training which cannot be redressed in other timely or cost-effective ways. The necessity for "filling gaps" in this manner will hopefully be minimized by adopting a total training systems approach to support material systems during system development. The possibility of using ET as a "quick fix," however, should not be discounted without careful consideration.

Team Training. Team training on the same system was provided by several of the ET components studied. This type of training seeks to build and sustain skills associated with task interdependencies required for successful system operation, through either providing stimuli to all personnel to be trained (perhaps in differential ways) or to key personnel whose actions and tasks cue other team members to perform their own tasks. Such training is of particular value when individuals operating dissimilar (but related) equipment on one system must perform together (e.g., ACTS, AWACS), or where there is redundancy in manning on similar workstations (e.g., Patriot). As for all other training, however, team training provided through ET should be based on sound, validated training objectives. Without more complete data than was available for this study, relatively little can be concluded about the characteristics of the team training provided by the components which supported team training.

One interesting phenomenon relating to team training was identified from interviews concerning the F-14 IFT. In this case, synthetic target information is principally presented to the Radar Intercept Officer (RIO) via the main radar display in the rear cockpit. The RIO engages in task performance in response to the stimulation provided by the ET component. As part of performing his tasks, the RIO interacts with the pilot to plan and coordinate aircraft maneuvering to intercept or engage the simulated radar targets. The pilot thus receives practice in precision manuevers and in crew coordination techniques and activities without receiving any direct stimulation from the ET component. Feedback on pilot performance comes from corrections by the RIO to improve engagement parameters and from the auxiliary radar display in the front cockpit, on which the pilot can view the simulated target's change in position relative to the F-14. In this fashion, the pilot receives highly mission-relevant training without explicit stimulation by the ET component because of the crew organization and task interdependency of crew duties. This is a characteristic which should be considered in the design of future ET components, since it provides an opportunity to provide training for crews without the necessity to give explicit, unique task stimulation at each crew position.

Coordinated Training for Multiple, Dissimilar Systems. Three ET components were identified in this study which (at least, theoretically) had the capability to provide training for operators of different types of systems linked by communication networks: ACTS, Missile Minder, and AWACS. Each of these three ET components can provide target information to platforms or sensors other than the system in which the ET component exists. In combined-arms or coordinated situations, such a capability can provide higher-level task practice in communications, command and control, or intelligence functions which promote effective combined use of systems. For example, AWACS ET is capable of sending real-time synthetic target data to other aircraft, to ground stations, and to shipboard command and control elements. Such capabilities should be considered for future systems which are principally oriented toward Command, Control, Communications, and Intelligence (C3I) functions, or which serve principally as sensor or data gathering platforms and feed data to other systems.

A particular caution is warranted when planning for ET components which can provide target or other data to other platforms or systems, however. In the current study, Missile Minder ET was not used in an on-line mode (although the capability was present), since there was the possibility of communicating synthetic target information without its being identified as such. The potential for introducing "bogus" target information into an operational situation, and having such information interpreted as "real" target information was considered to be unacceptable. Future ET components which incorporate such capabilities should have the ability to identify synthetic data introduced for training purposes as synthetic, if it is to be introduced into coordinated situations without restriction. Alternately, such information may be presented only during periods specifically set aside for training, to avert regrettable misinterpretations.

Scenarios and Scenario Requirements

A number of the ET components studied rely on pre-defined scenarios to provide practice and training opportunities for trainees. Typically, a limited number of pre-defined scenarios is available for presentation via the ET component. Anecdotal and interview data suggest that the small available number of scenarios provided in some cases (notably the Patriot TPT) restricts the quality and amount of training that can be provided. This reportedly is manifested by a situation where, after a number of exposures to each available scenario, trainees "learn the scenarios" (i.e., learn where and when in an exercise to expect particular targets to appear). In such a situation, the training value of the scenarios is quickly lost, since the trainee is responding to a known situation. This suggests that when pre-defined scenarios are to be used to implement ET, a larger number and variety of scenarios than is provided in the systems studied may be necessary to ensure effective sustainment training.

The nature and effects of the variables which determine the number and variety of scenarios required for a particular implementation of ET are currently not clear. No information was available regarding the decision process or variables used to identify the scenarios included in each of the ET components studied, so it is not possible to extrapolate from "lessons learned" from the nine systems examined in this effort. As part of the development of guidelines and procedures for the design and implementation of ET components in the future, some effort should be exerted to identify at least the major variables which drive the requirements for the number and variety of scenarios to be provided to ensure continued training value of ET components. Also, if possible, at least a tentative model for application of those variables should be developed, to provide, as a minimum, rough parametric guidance for scenario requirements.

ET Interactions with Logistics

Of the nine ET components studied, only two (AN/TPQ-29 and CSTS) had any reported effects on the hardware logistics of the systems with which they are associated. Both of these components are retrofits to their prime item material systems. This may have provided visibility of logistic impacts that would not be the case in concurrently developed ET components. As mentioned earlier, costs for concurrently developed ET components could not be identified during this effort. It is suspected that an attempt to segregate logistic impacts would encounter similar problems. On the basis of the data available, however, there is no indication that having an ET component results in any predictable impacts on hardware logistics.

It is speculated that the presence of ET components may have some beneficial impacts on hardware logistics in the long run. More consistent and frequent use of hardware systems to support training via ET may actually reduce the number and severity of on-condition maintenance requirements, since precipitating conditions are more likely to be noticed when a system is in use, and corrected before they lead to larger-scale problems. Also, improved operator and/or maintainer proficiency which may be provided by ET may lead to fewer "induced" faults, since overall skill levels may be improved and, thus, fewer errors in operating and maintaining the equipment will be made.

Software and Courseware Logistics

Providing training via an ET component implies that the software and/or courseware by which the ET component is implemented will have to be maintained and updated, both to maintain currency with the material system and to rectify problems with the training, if they exist. The software/courseware maintenance and update requirements for ET may impact the overall support manpower and equipment requirements for a system. ET updates are dealt with in a variety of ways in the systems studied. In general, a centralized update or configuration control authority periodically performs updates and development of new training materials or scenarios in response to requirements from units or other users of ET. The updates are then distributed to all using sites, and implemented.

In two cases (F-14 IFT, F-15 OBS), ET scenarios or courseware are part of or closely adjunct to general system software and are updated as part of the software update process. In the remaining cases, ET courseware or scenarios are distributed on installable or removable media, and are updated or revised separate from system software. In all cases except WWMCCS, however, the ET courseware or scenarios are implemented as <u>software</u> -- computer code, rather than data acted on by software.

This type of implementation requires considerably more effort in the training maintenance process than when ET courseware or scenarios are implemented as data or parameters to modify the actions of independent software. In none of the cases examined in this effort was an authoring system capability provided to support maintenance and update of ET scenarios or courseware. Such capabilities have been found to dramatically reduce both development and update time and effort when available for more conventional computer-based instruction. While there is no basis to estimate the amount of savings which may be realized from having authoring system capabilities to update ET training, such capabilities should be seriously considered for future ET components, to help to minimize the support manpower burden associated with the presence of the ET component.

APPENDIX A

PATRIOT MISSILE SYSTEM
TROOP PROFICIENCY TRAINER (TPT)

PATRIOT MISSILE SYSTEM TROOP PROFICIENCY TRAINER (TPT)

The Patriot Missile System is a surface-launched, radar-guided, anti-aircraft missile system. A Patriot firing battery has five major components, which are all mobile and transportable by ship, rail, airplane, and helo lift. These components are the engagement control station (ECS), radar set, electrical power plant, launcher/missile canister, and antenna/mast group. These components are shown in Figure A-1 as they would be deployed in a battery.

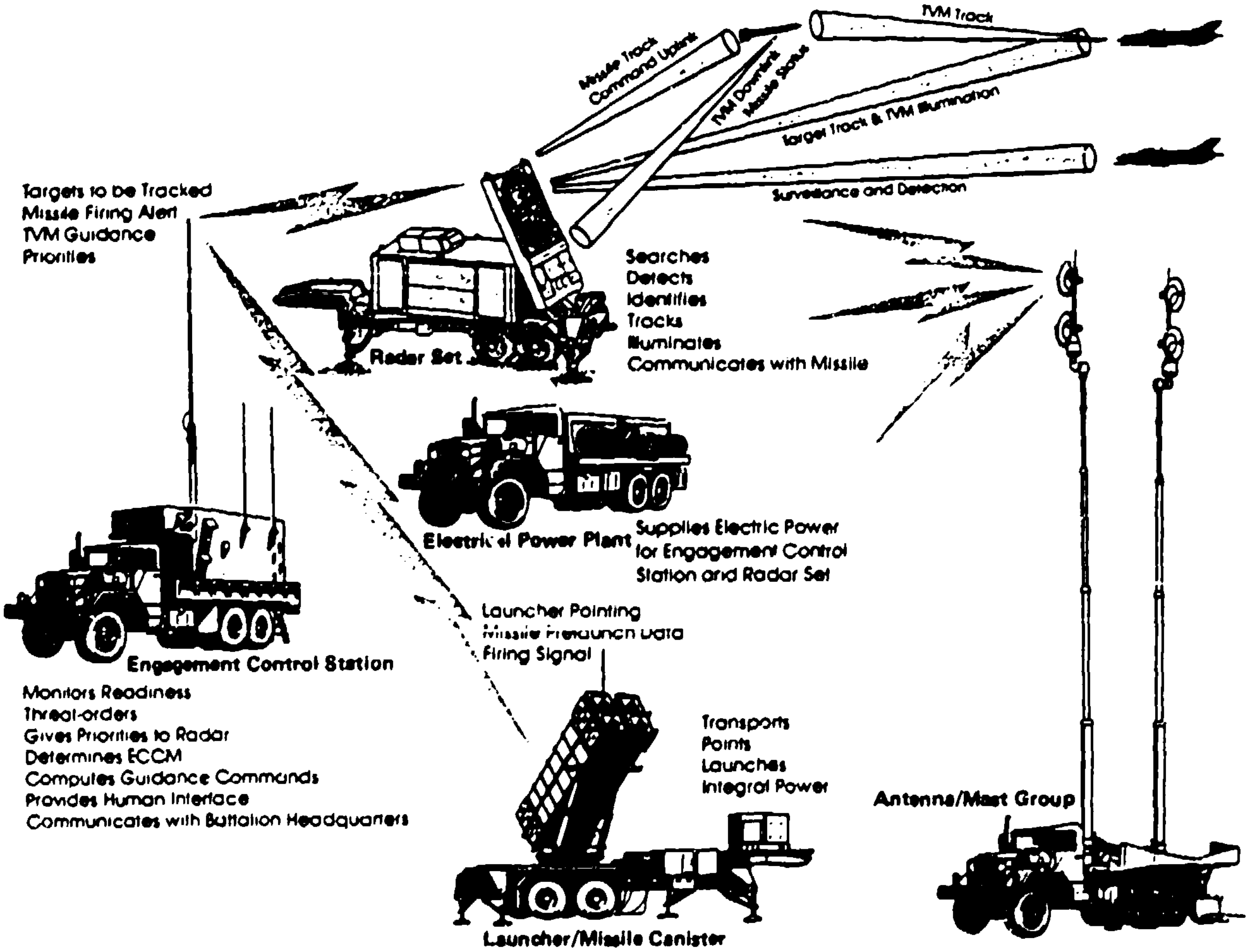


Figure A-1. Patriot Missile System Battery Compliment

When activated, the radar searches its designated air space and, upon detection, relays target information to the ECS. The ECS compares each target with the target tracks currently held and, if it is a new target, the system begins tracking it. The target is automatically identified, its engagement eligibility is determined, and threat orders are issued. Patriot is a highly advanced system designed to replace the IHAWK and Nike Hercules missile systems.

Component Descriptions

Engagement Control Station. The ECS is tasked with monitoring readiness, threat-ordering, giving priorities to radar, determining electronic counter-countermeasures (ECCM), computing guidance commands, providing a soldier-machine interface, and communicating with battalion headquarters. Within the ECS is the display and control group (operator stations) and the weapons control computer (WCC) which controls radar functions and launching stations, and provides guidance commands to the missile. The ECS is truck-mounted and has a VHF communications mast for remote control of up to eight launching stations.

Radar Set. The radar set is a multi-function phased-array radar that performs very high- to very low-altitude surveillance, target detection, target identifications, target track, missile track, missile guidance, and ECCM. It searches, detects, identifies, tracks, and illuminates targets, and communicates with the Patriot missile. It is trailer-mounted for portability.

Weapons Control Computer. Data processing takes place within the radar equipment and WCC. A library of known targets and their characteristics is compared with the detected target's characteristics. When a correlation is found, the target is given a classification. This relieves the operators from having to memorize vast amounts of target characteristic data, such as radar parameters or jamming characteristics. The data processor automatically responds to target ECM by applying ECCM. This also relieves operators from memorizing manual ECCM procedures which, in earlier systems, took time and often resulted in missed targets.

Antenna/Mast Group. The antenna/mast group has quick-erect antennas and amplifiers for UHF communications between the information and coordination central (ICC) of the Patriot battalion, the battalion communications relay group (CRG), and the battery ECS.

Launching Station. The launching station is remotely controlled from the ECS. It is a self-contained unit with a built-in power supply. Under ECS control, each launching station can launch up to four missiles at designated targets. Each missile is contained in a canister, which functions as a shipping and storage container as well as a launch tube. After launch, the missile is command-guided through midcourse. At that point, the system automatically selects one of four terminal guidance modes, depending on the nature of the target and the jamming being received.

Troop Proficiency Trainer. The Troop Proficiency Trainer (TPT) is a set of integrated software residing in the ECS and ICC computers. No special equipment is needed to operate the TPT. Each firing battery trains in a "stand-alone" configuration when practicing air defense artillery exercises on the ECS or ICC. The firing batteries and the battalion ICC can be networked by synchronizing the fire units and selecting a scenario designed for the network configuration. Practice in a network configuration provides the soldiers with sustainment training in the normal mode of operation--a battalion-directed air defense.

ET Training Features

Computer-Oriented Features. The Patriot TPT is not equipped with any special training features within its computer system. CAI, AI, and computer-generated imagery are not features of the TPT, even though the ECS provides a suitable environment for CAI.

Training Management Features. The TPT has a scenario authoring capability, which is the responsibility of the battalion training officer. A library of 17 scenarios is updated every quarter. The training officer chooses and installs five of the 17 scenarios. Scenarios can be written to train either individual Patriot ECS operators or all of the battalion ECS operators. Scenario time lengths are selectable; however, scenarios are preprogrammed, which prevents any on-line scenario modifications from being made. The TPT does not have adaptive training nor built-in record-keeping capabilities.

Automated Training Features. The TPT has no special automated training features. The TPT scenarios provide proper stimulation for practicing ECS operational tasks; however, without any automated feedback, performance recording, performance measurement, or report generation, there is a requirement for an over-the-shoulder training observer. The only report generated is a target summary/description, which can be printed after the training session. An example of the target summary printout is shown below in Figure A-2.

```
HH:MM:SS
TGTNO THRT  RT TLL  ENGSTAT  ID/SZ       TOLD IN ID:XXXXX/XXX
XXX/   XX  +XX +XX   XXXX/   XX/         LOCAL ID:XXXX/XXX

GEOREF   ALT SPEED  HDNG   JTYPE   TRTYPE   ID HISTORY
XXXXXXXX XXX  XXX   XXX    XXXXX   XXXXX      ORIGIN:   XXXX
IFF CONDITION:                              ECM EMIT:   X
    MODE: 4        1        2       3         POP-UP:   X
    CODE: XXXX     XXXX     XXXX    XXXX    PROHIB VOL:  X
RESPONSE: XXXXXXX XXXXXXX XXXXXXX XXXXXXX   RESTR VOL:  X
 QUALITY: XXXXXXX XXXXXXX XXXXXXX XXXXXXX    IFF EVAL:  XXXX
```

Figure A-2. TPT Target Data Printout

The information contained in the printout is somewhat useful for assessing engagement outcomes, but it is lacking any information about operator responses. A complete mission printout has one of these target data tables for each target. The alphanumeric data are represented in the figure above by X's. There is no difference between the printout for the TPT targets and the printout for the actual detected targets.

Scenario Control Features. The TPT does not have scenario freeze, scenario playback, or scenario fast-forward functions.

Instructional Features. The TPT does not have a demonstration mode, which a training officer might use to explain advanced target management techniques. It also does not have a user-help facility, which a trainee or training officer could use while running scenarios or operating the TPT equipment.

ET/System Coordination Features. The TPT is an integral part of the actual equipment. It uses actual equipment and simulates the task environment with a high degree of fidelity. The TPT disables the radar equipment, which makes it strictly an off-line device. It can be operated in a stand-alone configuration when training one battery or in a networked configuration. Network training requires using a scenario designed to train the battalion and synchronizing the time clocks in each battery. Networked configurations are the normal operational mode for Patriot batteries.

Factors Affecting Training with ET

Logistical Impact Factors. The TPT has not increased parts requirements, maintenance requirements, or equipment wear. There is no difference between equipment operation during a TPT scenario and during an actual mission except that, when the TPT is activated, it disables the actual radar and launchers.

Time Impact Factors. The TPT and the Patriot missile system are very reliable, with low system down-time ratings. Both the operators and the Patriot systems are available for training purposes, within the normal operational constraints and routine battery duties. The schedule for a typical Patriot fire section is two eight-hour shifts for training and one eight-hour shift for maintenance. The TPT was developed along with the Patriot system, and there are no significant design problems.

Operating Impact Factors. The Patriot was designed to be easy to operate and to facilitate the operator tasks capable of being automated. Tasks such as identifying targets based on radar characteristics are automated! eliminating the need for operators to memorize a large quantity of such information. The TPT is also simple to operate and requires a minimal amount additional instruction. Scenario authoring is probably the most difficult TPT task to train and requires special attention to ensure that realistic and meaningful scenarios are created. Changing from an operational mode to the TPT training mode is instantaneous and easy, as is the change back to an operational mode.

ET Training Functions

Task Categories. The TPT trains equipment operation tasks at the ECS and ICC. In a network configuration, it trains team operation tasks. Since the common operational configuration for Patriot is a networked battalion, it is important that the TPT have a network training capability. The TPT does not provide maintenance training.

Training Uses. The TPT is used primarily as an individual and team training device. It is also used for preparatory exercises prior to a readiness evaluation or before an operator is transferred to an overseas unit. Results of TPT preparatory exercises are used to identify areas of low operator proficiency, so that the operator can concentrate on strengthening the particular tasks associated with the weak area. The structured readiness evaluations used by the Army do not use the TPT capabilities, although it would not be difficult to create special scenarios for readiness evaluation teams to use when grading battalion performance.

Training Types. The TPT is a full-scenario training device which is capable of part-scenario training, provided that the scenario is authored for a specific mission area. It is possible to perform part-task training on the TPT in its present form, but part-task training is not normally performed with TPT.

Training Levels. The TPT is used for sustaining operator tasks. It is not used for initial training in the units, but it may be used by the schools to train the acquisition of skills on the actual equipment. Full mastery of skills is not currently trained using the TPT, but advanced scenarios, with higher demands placed on the operator, could be authored and used for this purpose.

APPENDIX B

MISSILE MINDER COMMAND AND CONTROL SYSTEM

MISSILE MINDER COMMAND AND CONTROL SYSTEM

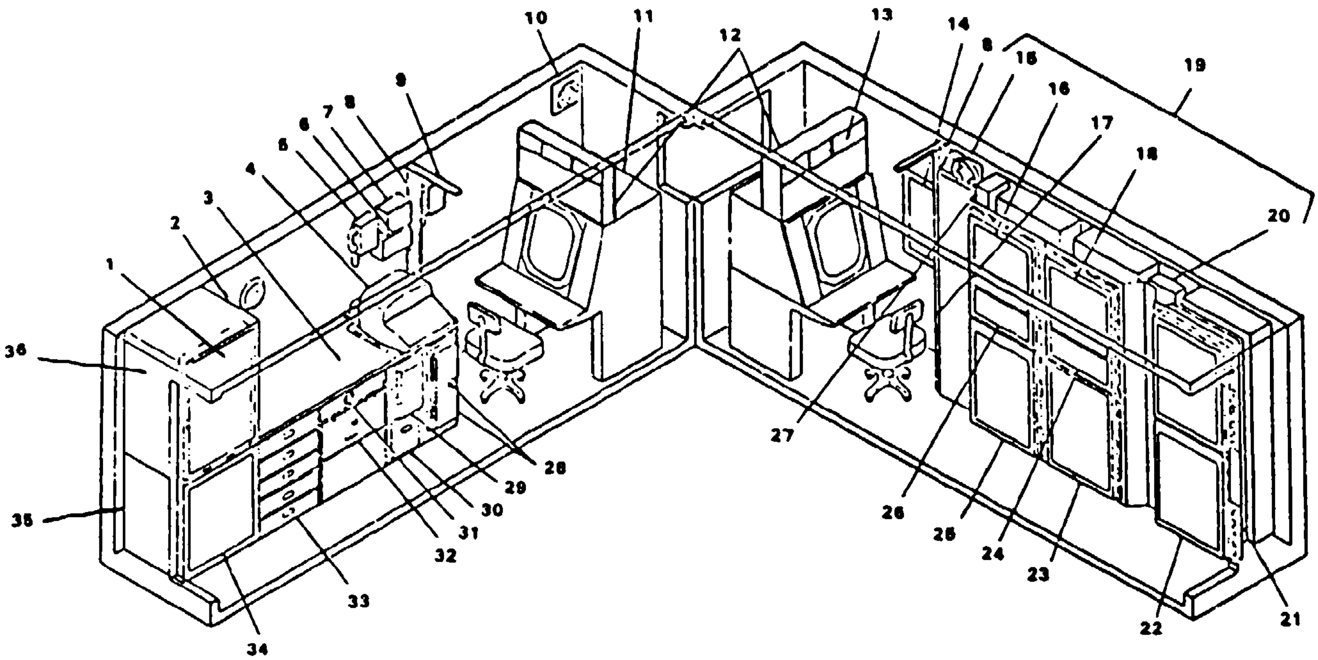
The Missile Minder Command and Control System provides the tactical command and control for air defense firing units. It commands and controls Nike Hercules, Hawk, and Patriot missile systems, at either the battalion or the group level. The major components include two self-contained situation display consoles, radar interface equipment (RIE), automatic data processing equipment, and communications equipment, which are all housed within the TSQ-73 shelter. The shelter is normally mounted on a five-ton truck for portability but can be mounted on a platform on the ground. Figure B-1 shows the Missile Minder shelter and the locations of the components inside it.

Component Descriptions

Display and Control. The two self-contained situation display consoles provide the operator with position-referenced situation data and the capability to enter, modify, and delete information in the data processor display files. The consoles have five possible modes of operation: tracking, tactical, tracking/tactical, monitor, and test. The data display group provides unit fire status information, weapons statusm alert conditions, and system fault conditions. Tactical information concerning track positions, weapon positions, maps, jam strobes, velocity vectors, safe corridors, pairing lines, and defended areas and points is displayed for the operator.

Radar Interface Equipment. The radar interface equipment (RIE) obtains the following information from local r dars: radar target and sweep position data, normalized radar data, video target data, and internally digitized data. It also accepts information from local identification friend-or-foe (IFF) equipment and decodes these IFF signals to identify aircraft, to recognize aircraft emergencies, to determine height of aircraft, and to track aircraft not detectable by the primary radar. The RIE receives the data, prepares the data for use by the automatic data processor and data display. group, correlates target positions to determine azimuth and range, updates target reports, and verifies valid targets.

Data Processor. The automatic data processor provides data processing of radar signals, simulation routines, communications, and display data for the consoles, and it mechanizes operator-initiated commands. It interfaces with all other equipment except the voice communication gear. It assigns the appropriate surface-to-air missile to each threat target and updates air defense units on status, condition, and activity changes.



1. Voice comm central panel
2. Patch panel
3. Maintenance bench
4. Keyboard printer
5. Voice comm station
6. Environmental control panel
7. Pressure sensing module control
8. Blackout curtain
9. Voice comm station
10. Blower (ducting removed)
11. Display console assembly
12. Status display panel
13. Display console assembly
14. Escape hatch
15. Blower
16. Radar interface equipment panel II
17. Radar interface equipment panel I
18. ADP status and control panel
19. Equipment rack
20. ADP interface panel
21. ADP external interface panel
22. Equipment rack 3
23. Equipment rack 2
24. Data comm panel
25. Equipment rack 1
26. Radar simulator panel
27. Radar interface panel
28. Magnetic tape unit
29. Module test set
30. Storage drawer
31. Oscilloscope
32. Safe
33. Storage drawers (5 places)
34. Main power panel
35. Main power enclosure
36. Voice comm central unit

Figure B-1. AN/TSQ-73 Missile Minder Shelter

Communication Equipment. The communications equipment provides voice and digital data links between the automatic data processor and the console operator, as well as among the members of the net. Voice communications are through a standard semi-automatic telephone switching system. Data communication is the interface between the automatic data processor and the remote-site data system.

ET Component. The ET component is integrated software in the operational system. Users of ET use actual equipment, including a keyboard, magnetic tape unit, keyboard/printer unit, and monochrome CRT display. Scenario set-up data are stored on a magnetic-tape cartridge, called a RAID tape, which is the only ET-unique equipment. Scenario data are extracted to a second magnetic tape unit. From the extracted data, a raid summary report, which includes basic performance information, can be printed out on the keyboard/printer unit. These performance data are not useful to a training officer, since they are limited to hits and misses.

ET Training Features

Computer-Oriented Features. The Missile Minder ET is not equipped with a CAI mode of operation, does not use AI processing, and does not have computer-generated imagery. The Missile Minder shelter presents a suitable environment for CAI, but a CAI capability has not been incorporated.

Training Management Features. Missile Minder has no adaptive training or on-line scenario modification capabilities. There are no built-in record-keeping capabilities. All scenario authoring is performed at the Software Support Center, Ft. Bliss, Texas, where the RAID tapes are authored. Thus, the Missile Minder systems has no unit-level scenario authoring capability. However, each unit has a library of RAID tapes from which to choose.

Automated Training Features. Missile Minder is capable of limited performance recording. The recorded data include the number of successful kills, missed targets, and missiles expended. These data are useful from the operational standpoint, but provide little help for the trainer or trainee. From these recorded data, Missile Minder generates a raid summary report, which is printed on the keyboard/printer unit. This printout provides a readout of performance information, as shown below in Figure B-2. ET in Missile Minder does not present any feedback to the trainee, nor does it have a performance-measuring capability.

Scenario Control Features. Missile Minder ET is capable of replaying a raid scenario at the display console. A replay is performed by rewinding the tape to a desired point and playing the scenario from that point. There is no scenario freeze or a scenario fast-forward capability.

```
CONFIGURATION.  XXXXXXXXX                                    PAGE XXXX
DATE: MM/DD/YY TIME: HH:MM:SS SITE: XXXXXXXX  RAID TAPE: XXXXXXXX

RAID SUMMARY REPORT

TRACK AND MISSILE COUNTS

HOSTILE TRACKS  XXX
UNKNOWN TRACKS  XXX
FRIENDLY TRACKS  XXX
TRACKS ENGAGED  XXX
MISSILE EXPENDED  XXX

ENGAGEMENT TERMINATIONS

EFFECTIVE     XXX
INEFFECTIVE   XXX
OTHER
AVERAGE MISSILES EXPENDED
   PER ENGAGED TRACK     XXX

ASSIGNMENTS

INBOUND  XXX
OUTBOUND  XXX

MANUAL  XXX
AUTO    XXX
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
CONFIGURATION:  XXXXXXXXX                                    PAGE XXXX
DATE: MM/DD/YY  TIME: HH:MM:SS  SITE: XXXXXXXX  RAID TAPE: XXXXXX

FIRE UNITS THAT EXPENDED ALL MISSILES

XXXXX
```

Figure B-2. Missile Minder Raid Summary Report

Instructional Features. Missile Minder does not have a demonstration mode that could be used by a training officer to show a trainee some advanced command tactics, target management, or missile control. There is no user-help facility to help the training officer to set up a scenario or use ET.

ET/System Coordination Features. ET in Missile Minder is fully integrated within the operational equipment. There are no significant differences between the operational equipment and ET, with the exception of the RAID tape. Although Missile Minder ET was designed to be used on-line, the simulated targets that would be generated in an on-line mode would enter the Air Force Communication Report Center (CRC) and be perceived as real contacts. As a result, all Missile Minder units operate ET in an off-line mode. Since Missile Minder is a command and control device, it is possible to coordinate training with Patriot, Hawk, and Nike Hercules missile battalions. Thus, Missile Minder ET can link simulated targets and provide training for Missile Minder operators, as well as for operators at these other participating units.

Factors Affecting Training with ET

Logistical Impact Factors. ET had no significant logistical problems other than equipment availability. ET is integral to the weapon system and did not increase the necessary number of parts. Although raid tapes are required for ET, they are not considered a significant factor. No additional maintenance requirements resulted from including ET, and no increase in equipment wear was indicated due to ET. Simulation fidelity is considered very good, with no notable differences between the actual operational environment and the ET stimulated environment.

Time Impact Factors. Overall, the Missile Minder system is very reliable and has a minimal amount of down time. The equipment is normally used for training purposes prior to a readiness evaluation, and it is seldom available for individual unit training. Since Missile Minder is a command and control system, the SOR requirements have had a significant impact on equipment availability for training. They have forced the ET to be used exclusively in an off-line mode.

ET for the Missile Minder was developed during the early stages of weapon system development. One significant design problem has been the amount of internal memory. Initially, Missile Minder had a 64 kilobyte memory, with 24 kilobytes needed for bootstrapping the system. This left 40 kilobytes available for data processing and other operational functions. Thus, a limited amount of space remained for ET processing commands. A future 64-kilobyte memory expansion is planned, to eliminate some of the memory constraints.

Operating Impact Factors. Both the operational system and the ET are considered simple to use. Initializing ET only requires installing the raid tape in the magnetic tape unit and starting it. To start or stop a raid tape scenario is nearly instantaneous. It is accomplished by pressing a switch.

ET Training Functions

Task Categories. Missile Minder ET trains individual equipment-operation tasks, as well as team tasks. Both types of tasks are trained simultaneously when raid scenarios are run with other units on the network. Display-console operating tasks can be trained separately when a raid scenario is run without other units participating. No maintenance training is possible with Missile Minder ET.

Training Uses. Although Missile Minder ET is capable of providing individual training, the equipment is seldom available for this purpose. Usually, ET is used for preparatory exercises before a readiness evaluation. This provides team training, since most preparatory exercises have various participating units. Raid tapes are also used during readiness evaluations, by the evaluation teams.

Training Types. Missile Minder ET is generally used for fullmission scenario training, but it is possible to have a raid tape which has only a part-mission scenario. The creation of such a raid tape depends on the Software Support Center. No part-task training is possible with Missile Minder ET.

Training Levels. Missile Minder ET is used for sustaining operator proficiency. All initial training is performed at the school, and there is no provision for training operators to a mastery-level of performance. Mastery-level training is possible if a raid tape with a challenging scenario is created at the Software Support Center.

APPENDIX C

IMPROVED HAWK (IHAWK) MISSILE SYSTEM TPQ-29 TRAINER

IMPROVED HAWK (IHAWK) MISSILE SYSTEM TPQ-29 TRAINER

IHAWK is an all-weather, radar-guided, anti-aircraft missile system. It is deployed either in a "square" configuration, which has one base firing platoon and one assault firing platoon, or a "triad" configuration, which has one base firing platoon and two assault firing platoons. Assault firing platoons and base firing platoons are deployed in different locations. The weapon system consists of a several remotely controlled radar units for target detection and tracking, missile launchers, a battalion-level control station, and a battery-level control station. Figure C-1 shows an IHAWK missile system in a square configuration.

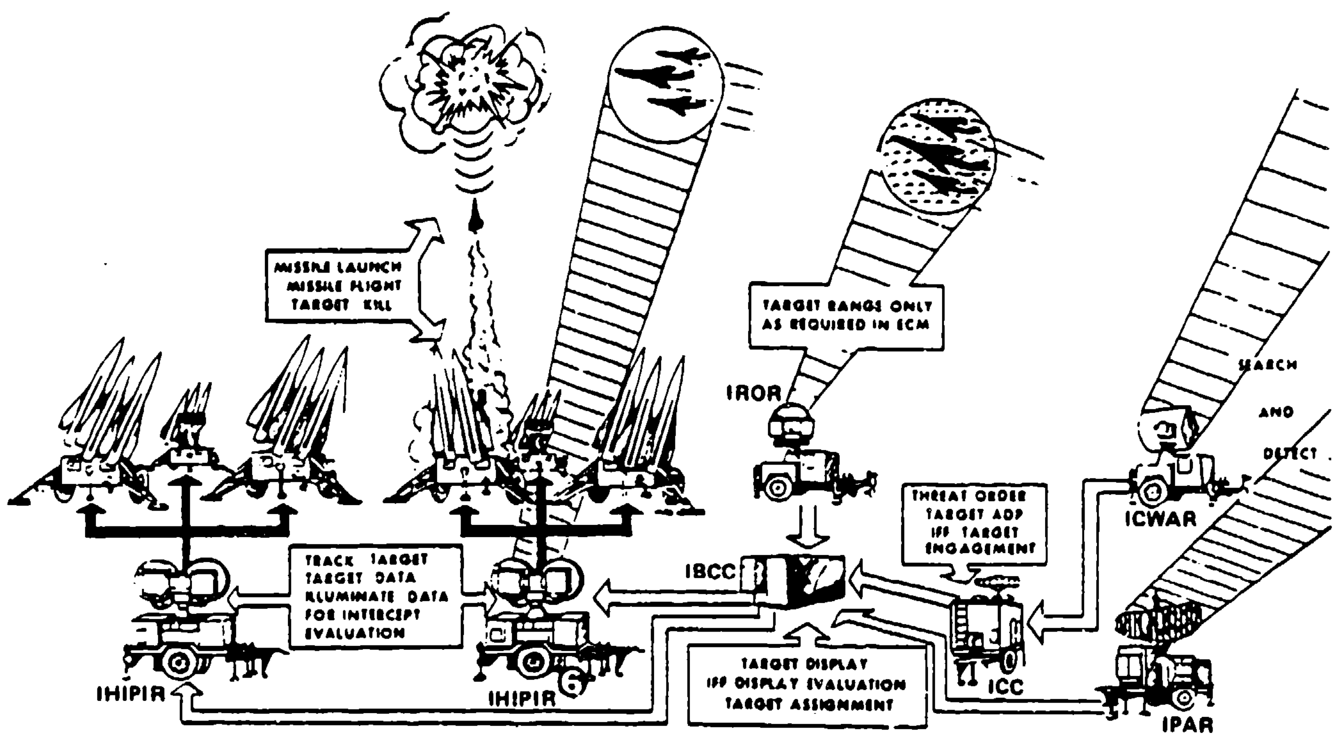


Figure C-1. IHAWK Missile System Components

A mission sequence begins with the improved continuous-wave acquisition radar (ICWAR) and improved pulse-acquisition radar (IPAR). These are the search and detect radars. When the ICWAR or IPAR detects a target, it transmits target information to the information coordination central (ICC) and the improved battery control central (IBCC). At the ICC, the target is processed by IFF equipment and automatic data processors (ADPs). Once the target has been identified at the ICC, the target information is transmitted to the IBCC.

In the IBCC, the target data are presented on the displays, along with target assignments for the battery. The tactical control officer in the IBCC selects a target for engagement and assigns it to a firing section. The improved high-power illuminator radar (IHIPIR) tracks the target and provides a reference signal for the missile. The improved range-only radar (IROR) provides ranging information for the target in an ECM environment. In flight, the missile compares the transmitted signal from the IHPIR or IROR with the reflected signal from the target, and adjusts its intercept course based on target course and speed.

Component Descriptions

Display and Control. Each battalion has one ICC, and each battery has one IBCC. The IBCC receives assignments to engage targets from the ICC. A tactical control officer assigns one of the battery firing platoons to engage the target. All commands between the IBCC and the firing platoon equipment are on a digital link, as are commands from the ICC. The ICC and IBCC also communicate on a voice channel.

Radar Equipment. The IHAWK weapon system has five trailer-mounted radar units per square battery and seven per triad battery. The first radar unit is the ICWAR, which provides low- to medium-altitude search and detection capabilities. The second radar unit is the IPAR, which provides medium- to high-altitude search and detection capabilities. Each square battery also has two IHPIR radar units (each one being linked to three launching stations), which track targets and illuminate the targets for intercept evaluation. A triad battery would have two additional IHPIR radar units. The last radar unit is the IROR, which provides range-only illumination of a target in an ECM environment.

Launching Stations. Each square battery has six trailer-mounted launching stations. These are separated into two firing platoons. A triad battery has nine launching stations, divided into three firing platoons. Each launching station has three missiles and is remotely controlled from the IBCC. Once a missile is launched, it is guided by its own guidance system, based on target reflections from the IHPIR or IROR radar units.

ET Component. The AN/TPQ-29 is van-mounted, with its own its own console for monitoring and initializing the training sessions. There is one TPQ-29 per battalion. It is periodically rotated among the batteries in the battalion. It is a strap-on training device, using cables to carry the signals that stimulate the operational equipment.

ET Training Features

Computer-Oriented Features. The TPQ-29 is not capable of CAI and does not use AI or computer-generated graphics. The only functions of the TPQ-29 are to stimulate the operational equipment and to provide a suitable environment for CAI.

Training Management Features. The TPQ-29 does not have an adaptive training capability. It has a scenario authoring capability, but IHAWK battalions are not given specific guidelines or target parameter limits to ensure that meaningful training scenarios are developed. It also is not equipped with a recordkeeping or on-line scenario modification capability.

Automated Training Features. The TPQ-29 does not have any automated trainee features. There are no performance feedback, performance recording, performance measuring, or report generation capabilities. This requires all evaluation and feedback to be done over-the-shoulder.

Scenario Control Features. The TPQ-29 does not have any scenario control features. All scenarios are pre-programmed, with no script input capability. This increases the importance of the careful scenarios authoring.

Instructional Features. The TPQ-29 has neither a demonstration mode, which could be used by a training officer to illustrate advanced equipment operations for the trainee, nor a user-help facility, which could aid the training officer in the operation of the TPQ-29, since it is a specialized piece of equipment with no commonalities with the IHAWK system.

ET/System Coordination Features. The TPQ-29 is a strap-on ET device. It is only capable of off-line operation. The off-line restriction has a negative effect on the equipment availability, since IHAWK battalions have very stringent State-of-Readiness (SOR) requirements. Not only has the fact that it is a strap-on device restricted the availability of the equipment for training but has also increased the difficulty of using the TPQ-29. It is not capable of presenting simulated targets on the communications net, for training coordinated tasks with other units.

Factors Affecting Training with ET

Logistical Impact Factors. Because it is an added-on training device that straps onto the actual equipment, the TPQ-29 has many unique parts which had to be added to the IHAWK battalion spare parts inventories. For this same reason, battalion maintenance responsibilities increased. Equipment wear has increased due to the difficulties of hooking the TPQ-29 to the actual equipment. For example, one difficulty in particular is the male-to-female connections. Connecting the TPQ-29 often produces bent male connector pins, which require repair before they can be used again.

Time Impact Factors. One of the major factors limiting the use of the TPQ-29 has been the low reliability of IHAWK itself. Often when the TPQ-29s have been available for training, the IHAWK systems have been unavailable. Also, personnel are seldom available for training, due to additional battery duties or operational requirements. Training staff is also severely limited by battalion tasking. The training time problem is exacerbated by the fact that there is only one TPQ-29 per battalion, forcing each battery to share the time for the TPQ-29. Generally, each battery is scheduled for two 16-hour training periods per month.

A factor that contributed to the availability problem is that the IHAWK missile system was first developed in the early 1960s, when trainers like the TPQ-29 were neither cost-effective nor technologically feasible. When ET became both feasible and cost-effective, the TPQ-29 was developed, long after initial weapon system delivery. This is what led to the strap-on concept, since it is cheaper to build an ET device without having to modify all the existing IHAWK weapon systems. Building strap-on systems also has no effect on unit readiness, since units are not losing weapon systems during the modification process.

Operating Impact Factors. The TPQ-29 and the IHAWK system are not real difficult to operate, but they lack the user-friendliness that would make it an easy system to use. The main difficulty has been hooking the TPQ-29 to (and unhooking it from) the IHAWK system. Although it is theoretically possible to switch from the simulator mode to the tactical mode in 15 minutes, the average user estimate of hook-up or disconnect time is one hour--and some hook-up times have been more than 24 hours. Thus, it can take more time to hook up the TPQ-29 than a battery may have available for using the device. An additional problem is that the TPQ-29 puts out lower signal levels than is normal for the operational equipment. This forces operators to increase the signal gain to maximize target detection. Many users feel that this detunes their IHAWK system, and they do not like the TPQ-29 for that reason.

Training Functions of ET

Task Categories Trained. The TPQ-29 is used primarily to train individual operator tasks. The only team tasks trained by the TPQ-29 are among the operators of one IHAWK system. The TPQ-29 is not capable of maintenance training.

Training Uses. The TPQ-29 is only used for operator training. The initial concept of the TPQ-29 was to provide supplemental training after an operator leaves school and arrives at the unit. The school fails to train many of the critical operating tasks, leaving much of the operator training to the unit. The only team training is between the enlisted operator/repairman and the artillery officer.

Training Types. The TPQ-29 is primarily a full-mission-scenario ET device, but it is capable of part-mission-scenario training if the scenario is authored that way. The TPQ-29 is not capable of part-task training.

Training Levels. The TPQ-29 is primarily used to train the skills not trained at the schools. The fact that the school was not teaching all of the critical operator tasks and skills was a prime reason for developing the TPQ-29. It also is used to sustain the skills learned at the unit and in the school. It is not used to train beyond basic operator performance requirements, as for full-mastery level training.

APPENDIX D

WORLD-WIDE MILITARY
COMMAND AND CONTROL SYSTEM (WWMCCS)

WORLD-WIDE MILITARY COMMAND AND CONTROL SYSTEM (WWMCCS)

WWMCCS is a communications network used by the U. S. tri-services and by allied forces. Thirty-three of the 34 WWMCCS sites are connected on an information system called the WWMCCS Information Network (WIN). The Keesler WWMCCS site, which functions only as a training site, is the only site not included on WIN. This is due to the high security nature of WIN. WIN provides resource information (e.g.; number of ready aircraft at base "X," number of ready missiles at base "Y," number of ready infantry platoons at base "Z," etc.) that is used by the Joint Operations and Planning System (JOPS) to make logistical and tactical decisions. WIN uses satellite and land communication links to facilitate the network.

Component Descriptions

Main Unit. WWMCCS is made up of a series of general-purpose computers with many user stations. The computers are connected to the communication equipment for world-wide information transfer.

ET Component. The WWMCCS training mode is selectable or deselectable in less than a minute. There is a simulation mode that is capable of issuing messages concerning resource availability and possible tactical requirements for training joint operations and planning systems (JOPS) operators. Little data was available about the simulation capabilities, but it is known that WWMCCS simulates on a very high tactical level, rather than simulating a specific target environment. There is a scenario library with scenarios authored by the Joint Chiefs of Staff (JCS) which are used to test operational readiness. Also, WWMCCS is capable of running CAI tapes to teach various related knowledges.

ET Training Features

Computer-Oriented Features. Each WWMCCS site can run CAI tapes. The tapes are produced at Keesler Air Force Base or at the WWMCCS site. The CAI system is capable of sending trainees who fail particular tests through remedial instruction automatically. Should the trainees fail a second time, they are returned to the beginning of the lesson. Scores are stored for each trainee, as well as which questions were missed and the time it took to complete the lesson.

There are currently 25 courses available with 185 to 190 lessons. A six-lesson course takes about one year to develop and author, before it is published and sent to the other WWMCCS sites. Tapes are validated in the field and the trainee results are sent to Keesler AFB, to aid in lesson refinement. The topics trained with CAI vary widely.

They include lessons on basic equipment operation, computer programming, and even CAI authoring procedures. WWMCCS does not use AI or have computer-generated imagery capabilities.

Training Management Features. The CAI is capable of assigning a trainee to remedial instruction, which is considered a form of automated adaptive training. Units do not author simulation scenarios but can author their own CAI tapes. WWMCCS has a built-in recordkeeping feature for maintaining taining performance information. Trainee results from CAI are sent to Keesler AFB, to aid in CAI tape revision.

Automated Training Features. No data on automated features of the simulation system were available; however, the CAI has automated performance measurement, monitoring, recording, and feedback. It is not certain whether a report can be generated by WWMCCS after a CAI session.

Scenario Control Features. No data were available about the scenario control features of the WWMCCS simulation mode. The scenario freeze, playback, and fast-forward features do not apply to the CAI mode.

Instructional Features. The CAI mode does not have a demonstration capability or a user-help facility. No data were available about the simulation mode.

ET/System coordination. Both the simulation mode and the CAI mode are integrated into the operational equipment. With the multiple user stations, a large number may be used for CAI while others are being used for operational purposes. This gives WWMCCS an off-line and an on-line capability. The entire WIN may have a scenario run on it, making it possible to train and assess the readiness of the whole network.

Factors Affecting Training with ET

Logistical Impact Factors. WWMCCS has no notable logistical impact factors. Adding the simulation and CAI capabilities did not increase the number of parts required, maintenance requirements, or equipment wear. There are no differences between the operational equipment and the ET equipment. Additional software support was required for the CAI training system, and it is provided by the training unit at Keesler.

Time Impact Factors. WWMCCS is a highly reliable system which has few system failures. Trainees are always available for training, within the restrictions of their regular duty requirements. The equipment is always available for training purposes, within the constraints of operational needs. No problems resulted from having ET added after initial system delivery, since there were no hardware changes to the system---only software additions.

Operating Impact Factors. Both the CAI and the simulation modes are easy to start or stop using WWMCCS. WWMCCS is an easy system to operate, as is its ET. It takes one minute to start or stop a WWMCCS CAI tape or simulation sequence.

ET Training Functions

Task Categories Trained. WWMCCS CAI trains the knowledges associated with individual equipment operation tasks and team operation tasks. The simulation mode trains team tasks and tactical decision tasks. Equipment operation is not really trained; instead, ET trains reaction performance and message response.

Training Uses. WWMCCS CAI is mainly used for individual training; the simulation mode is usually used as a team trainer as well as a readiness assessment tool for the Joint Chiefs of Staff. The simulation mode is not used very frequently.

Training Types. WWMCCS simulations are full-mission scenario simulations. A part-mission scenario could be authored, but it is not likely for the WIN to train using a partial scenario. Part-task training is not possible on the WWMCCS. CAI is a special type of training in itself.

Training Levels. After assembling the data about the simulation mode and CAI mode, WWMCCS ET was evaluated to determine the level to which tasks were trained. WWMCCS CAI was found to train both initial-level and sustainment-level knowledges. The simulation mode is strictly used for sustainment training and evaluation. No skills are trained to full-mastery levels, but it is possible if a scenaiio is authored for this purpose.

APPENDIX E

F-15 ON-BOARD SIMULATION (OBS) SYSTEM

F-15 ON-BOARD SIMULATION (OBS) SYSTEM

The F-15 is a fighter/bomber/interceptor aircraft. The F-15 can deploy air-to-air missiles, air-to-surface rockets and bombs, and it has a gatling gun for air-to-air and air-to-ground engagements. The sensors used are radar and visual sites. A Heads-Up Display (HUD) projected on the cockpit windshield shows target location, gun cross, and aircraft flight parameters. The pilot uses his control stick for maneuvering, communications, and weapons delivery.

Component Description

Electronics Equipment. The F-15 is equipped with a central computer which controls the radar, IFF interrogator, inertial navigation, HUD, and other instrument and electronic functions. The radar system is a lightweight, long-range radar, capable of detecting small targets at all altitudes. The radar is used for intercept missions and radar-guided air-to-air missiles. The IFF interrogator identifies the targets for the pilot and a programmable signal processor enhances radar capabilities with the HUD for close-in combat. Figure E-1 shows the HUD as it appears in the cockpit, with its symbology.

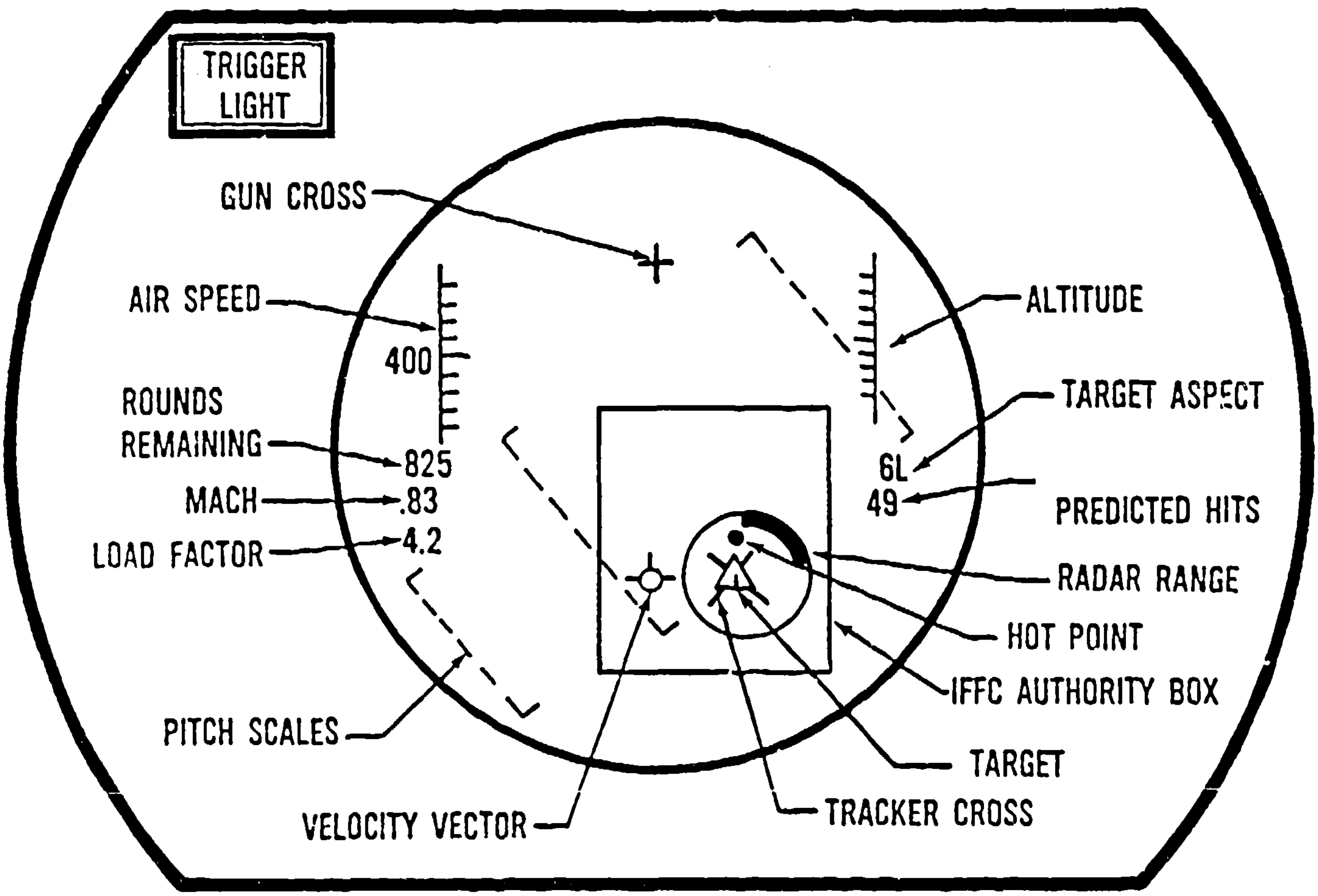


Figure E-1. F-15 Heads-Up Display (HUD)

ET Component. The OBS system is software that is integrated in the aircraft's digital computers. Activation or deactivation takes less than one minute and is very simple. The simulated targets are: a flying target, when in the air-to-air mode, or a fixed ground target, when in the air-to-ground mode (both of which are displayed on the HUD). The same operational displays and controls are used for training with the OBS system as are normally used operationally. Bullet scoring models are contained in the Air Combat Evaluator (ACE) software residing in the aircraft digital computer.

ET Training Features

Computer-Oriented Features. The OBS system does not have a CAI capability. An F-15 aircraft would not seem to be an appropriate environment for CAI. The software does not use AI technology or computer-generated imagery.

Training Management Features. The OBS is not an automated adaptive training system. Numerous encounters are stored in the computer memory and are randomly selected for the pilot. There is no scenario-authoring capability, but the random selection and the number of encounters stored reduce the need for one. There is no built-in student recordkeeping facility. A recordkeeping facility would most likely have to be an external device that would receive data from some kind of flight data recorder. All scenarios are preprogrammed, with no on-line modification capabilities.

Automated Training Features. The OBS does not provide performance feedback meaningful for training. The pilot is shown the predicted hits and the position of his bullet stream relative to the target or, in the case of the air-to-ground engagement, the distance from a target that a bomb landed. There is no recording of scenario dynamics or operator performance, which could be used for reconstruction of the scenario events for debrief and detailed analysis. There is no automated performance measurement other than the number of predicted hits. The F-15 does not have a printer and the OBS does not extract data that could be used for report generation.

Scenario Control Features. The OBS does not have a scenario freeze or scenario fast-forward capability. The F-15 is not a suitable site for a scenario playback, and without the data extraction capability, no other site can be used for debriefing on the scenario.

Instructional Features. There is no demonstration mode or user-help facility in the OBS system. Both of these features may be undesirable, due to the nature of the weapon system (one-seater); however, both could be useful for showing pilots who have not used the OBS how to use it.

ET/System Coordination Features. The OBS is fully integrated into the weapon system computers. When it is run in an on-line mode, it presents all of the enhanced operational characteristics of the aircraft, including the predicted hits and the bullets-at-target-range (BATR) symbol. The OBS does not link simulated targets to other participating units. It is used solely as a single-aircraft trainer. In fact, when training with the OBS, other aircraft are not permitted in the practicing aircraft's airspace, for safety reasons.

Factors Affecting Training with ET

Logistical Impact Factors. The OBS did not increase the number of parts, maintenance requirements, or equipment wear. There are no equipment differences in the OBS; however, with respect to an actual combat environment, the HUD makes up a small portion of the pilot's field of view, making targets which pass off the HUD disappear until they are positioned within the HUD field of view again. This prevents training in specialized skills, such as air combat maneuvering tactics (i.e., an ability to manuever relative to an adversary aircraft and to close in for a shot while guarding against counter-manuevers). An additional difference is that pilots do not experience the stimuli that are present when weapons are actually fired on a target (i.e., vibration or sound). Thus, trigger control is not trained using the OBS.

Time Impact Factors. F-15 aircraft have high reliability, which makes them available for training, within the normal constraints of operational requirements. Pilots are available for training, within the constraints of their regular duties. The OBS has been developed as a result of the integrated flight/fire control (IFFC) program. The IFFC program started with the F-15B, after its initial delivery to the Air Force. No problems have been identified as a result of adding the OBS, although the OBS is still in the experimental phase and has not been implemented into all active Air Force squadrons.

Operating Impact Factors. The OBS is easy to engage and stop. Difficulty levels are selected by the pilot, which permits training to be carried out at various skill levels. The F-15 aircraft is an extremely sophisticated aircraft that requires extensive training to qualify pilots and to maintain their skills and knowledges. The OBS is a simple system to operate, with one switch action that engages or disengages the OBS in less than one minute.

ET Training Functions

Task Categories. The OBS is used for training gunnery and bombing skills against ground targets (when in air-to-ground mode) and gunnery skills against air targets (when in the air-to-air mode). The OBS provides training for equipment-operation tasks only. No team tasks, such as coordinated bombing and strafing attacks, are trained by the OBS. The OBS does not train any maintenance tasks.

Training Uses. The OBS is used for training individual pilots in gunnery and bombing skills. There is no team training capability, and the OBS is not used for preparatory exercises or readiness evaluations.

Training Types. The OBS presents scenarios for air-to-air or air-to-ground engagements. These engagements are part of a typical mission for an F-15. Thus, the OBS is a part-mission scenario training device. The OBS is not suitable for part-task training.

Training Levels. The OBS is used to sustain pilot proficiency in particular skills. The OBS is not suitable for initial training. It may be used for full-mastery training if difficult scenarios are stored in the computer.

APPENDIX F

AIRBORNE WARNING AND
CONTROL SYSTEM (AWACS)

AIRBORNE WARNING AND CONTROL SYSTEM (AWACS)

The E-3A aircraft (a modified Boeing 707-320B) is the platform on which the AWACS is deployed. AWACS includes an array of radar, IFF, and communications equipment and provides a jam-resistant surveillance system used for command, control, and communications. The aircrew duties are divided into the following six functional mission areas: battle management, surveillance, weapons, communications, data processing and display, and sensor systems.

Component Descriptions

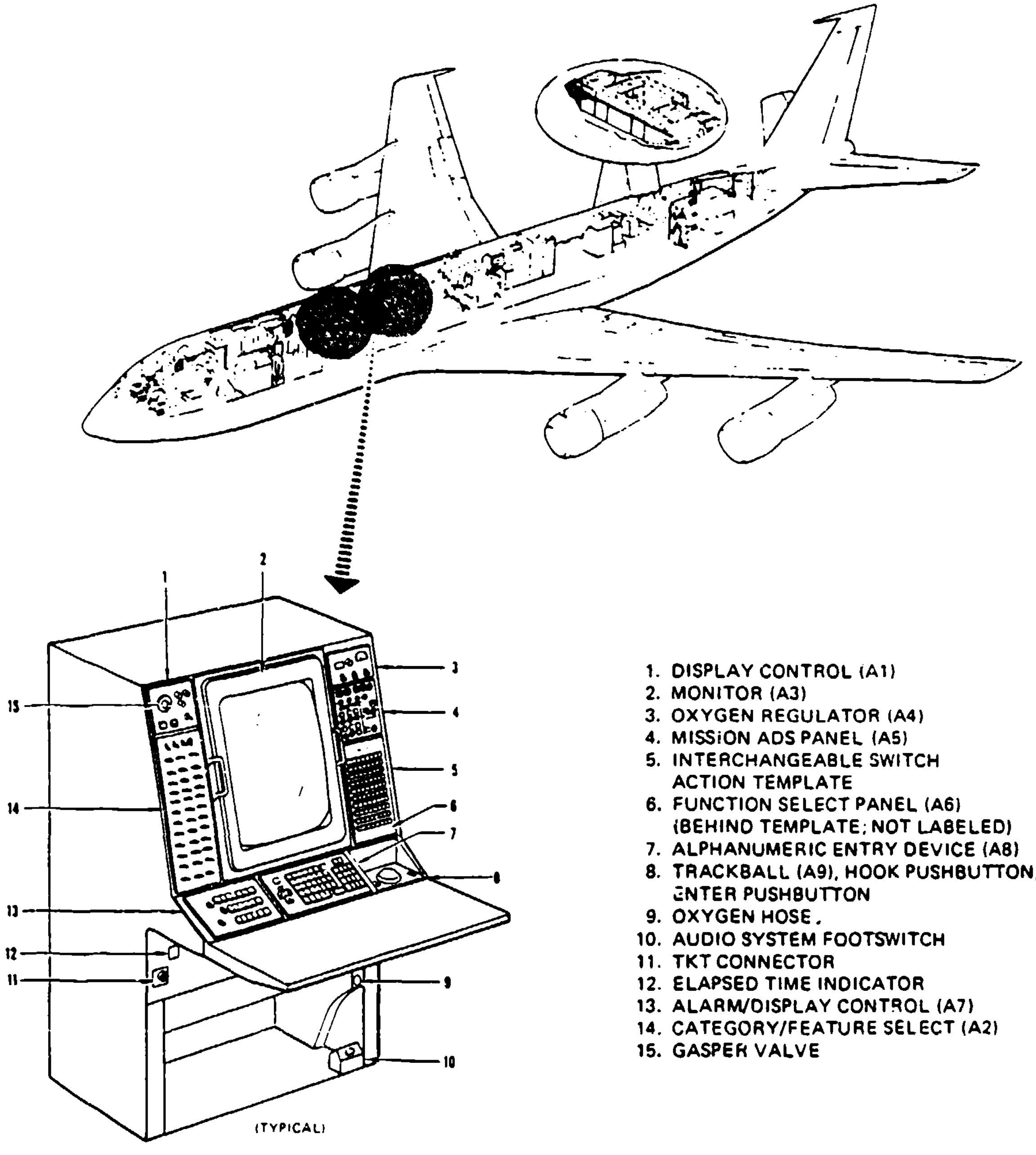
Operational System. The main sensor of the AWACS is its radar. There are several different radars employed on the aircraft for air and surface surveillance. IFF equipment automates target identification. The main control station for AWACS is the situation display console (SDC). There are six SDCs in the E-3A aircraft, as shown in Figure F-1.

ET Component. The AWACS ET consists entirely of the software residing in the AWACS computers. Training is performed on the actual equipment, with no additional equipment being required. Scenarios are selected, run, and installed (created) at the SDC. Also, simulator tapes that are created at the ground training facility are available to be played. Activating a scenario from a simulator tape or installing a scenario manually takes at least 15 minutes. Entering the desired parameters for the scenario is the time consuming part of installation. The deactivation of a training scenario is instantaneous and occurs automatically when an alert is received by AWACS. A training scenario can also be manually deselected by the operator at any time.

ET Training Features

Computer-Oriented Features. The AWACS ET component does not have a CAI capability. A CAI capability might be useful on missions that have long flight times to the tactical area. On the ground, CAI would probably not be useful in the aircraft since it would require the aircraft to be powered up. AWACS ET does not use AI technology or computer-generated imagery.

Training Management Features. The AWACS ET component does have a scenario-authoring capability. Scenarios are created at the training facility and placed on a magnetic tape for playing in flight, or the Mission Crew Commander (MCC) can direct the simulator supervisor to prepare a scenario in the aircraft. The MCC or simulator supervisor can also modify scenarios while they are running if it was authored in the aircraft. Taped scenarios are preprogrammed and cannot be modified while they are running. AWACS ET is not automatically adaptive and does not have a built-in recordkeeping capability.



1. DISPLAY CONTROL (A1)
2. MONITOR (A3)
3. OXYGEN REGULATOR (A4)
4. MISSION ADS PANEL (A5)
5. INTERCHANGEABLE SWITCH ACTION TEMPLATE
6. FUNCTION SELECT PANEL (A6) (BEHIND TEMPLATE; NOT LABELED)
7. ALPHANUMERIC ENTRY DEVICE (A8)
8. TRACKBALL (A9), HOOK PUSHBUTTON, ENTER PUSHBUTTON
9. OXYGEN HOSE.
10. AUDIO SYSTEM FOOTSWITCH
11. TKT CONNECTOR
12. ELAPSED TIME INDICATOR
13. ALARM/DISPLAY CONTROL (A7)
14. CATEGORY/FEATURE SELECT (A2)
15. GASPER VALVE

F-1. Situation Display Console of AWACS

Automated Training Features. The AWACS has a data extraction capability which, when used during a scenario, records scenario dynamics and operator actions. These data are used for reconstructing the scenario for a detailed analysis and to aid in debriefing. These data are also used for in-flight replay. All performance feedback and measurement is done over-the-shoulder, since there is no automated capability. Although AWACS has a printer, no report is generated from the scenario recorded data.

Scenario Control Features. The AWACS ET component has scenario freeze, scenario playback, and scenario fast-forward capabilities. The MCC controls the scenarios from the SDC, where the scenario control options are selectable.

Instructional Features. AWACS ET does not have a demonstration mode, which an MCC would find useful to train MCC candidates. There is no user-help facility, which would be useful for the MCC candidates when learning to operate ET.

ET/System Coordination Features. This ET component is software that is integrated into the operational equipment. This device can be used on-line or off-line. It can also send simulated targets to other participating units on the communications net, for coordinated training exercises.

Factors Affecting Training with ET

Logistical Impact Factors. No AWACS ET logistical problems were indicated. There was no increase in parts, maintenance requirements, or equipment wear as a result of installing the ET component. The ET component has some specialized procedures for running a simulation; however, these procedures are aided with cues and menus.

Time Impact Factors. AWACS ET was designed and developed along with AWACS. AWACS is a reliable weapon system and is normally available for operations or for training. The ET system is normally used after an aborted mission. This would occur when a subsystem (such as the radar) fails, thus preventing the aircraft from being able to complete the mission.

Operating Impact Factors. AWACS ET is easy to operate from startup to shutdown. AWACS itself is very sophisticated, with many operators interacting together, and it is moderately difficult to operate. Starting an ET scenario takes approximately 15 minutes, which is a rather long period of time. It takes less than one minute to return to the operational mode from the ET mode. If during an ET training session the AWACS receives an alert from AWACS sensors or from another AWACS unit, the ET system is automatically shutdown and AWACS is returned to the operational mode.

ET Training Functions

Task Categories. The ET component trains the operators in equipment operation and in their team operation tasks. The AWACS is a sophisticated weapon system, with many sensors and many operators. ET provides them with training in their own positions and trains them to interface with the other operators. ET does not provide any maintenance training.

Training Uses. ET is used for training individuals to operate equipment at their own stations and for training teams of operators. In addition, other units can participate in coordinated training with the AWACS. ET also is used in preparatory exercises prior to readiness evaluations. ET is not used for readiness evaluations.

Training Types. ET is capable of providing full-mission scenarios and part-mission scenarios. Which type of scenario is prepared depends on the author. ET is not used for part-task training, although scenarios could be developed to support part-task training.

Training Level. AWACS ET provides sustainment training for operators and teams. It also provides a medium for training to full-mastery level when a scenario is developed for that purpose. Full-mastery-level scenarios would train at an intensity not normally encountered during training missions or exercises, but are possible in actual combat. All initial training is provided at the school.

APPENDIX G

F-14 IN-FLIGHT TRAINING (IFT) SYSTEM

F-14 IN-FLIGHT TRAINING (IFT) SYSTEM

The F-14A aircraft is a carrier-based fighter. Its armament consists of air-to-air missiles and a gatling gun. It has an array of sensors and electronic equipment that includes radar, IFF, ECM, and ECCM. The aircraft is mainly used for Combat Air Patrol (CAP). The aircrew consists of a pilot and a radar intercept officer (RIO), both of whom operate the electronic sensors.

Component Description

Weapon System. The primary sensor for the F-14 is the long-range radar, which can detect small targets at all altitudes and speeds. The RIO is the primary radar operator, but the pilot can also operate the radar. ECM and ECCM equipment provide the F-14 with the capability to operate in most hostile environments. The weapons employed by the F-14 include three air-to-air missiles: one long-range radar-guided missile, one medium-range radar-guided missile, and one close-range heat-seeking missile. Also, for close-in air-to-air and air-to-ground combat, the F-14 is equipped with a 20-mm gatling gun.

ET Component. The IFT is software contained in the F-14 central computer. Activation requires one switch action by the pilot and three by the RIO. The IFT provides scenarios for training the deployment of weapons against radar contacts. No special equipment is used for training with the IFT, since it stimulates the operational equipment and is contained in the aircraft computer.

ET Training Features

Computer-Oriented Features. The IFT does not have a CAI capability. The F-14 does not appear to provide an appropriate environment for CAI. The IFT does not use AI technology or have computer-generated imagery.

Training Management Features. The IFT does not have adaptive scenarios. Targets fly in preprogrammed paths that are randomly selected by the IFT--or the crew members can select a specific scenario. Every quarter, a weapons improvement board is held which discusses IFT improvements and other weapon-related improvements. The IFT is not updated until the weapon system has been designated for approved improvements. There is no built-in record-keeping feature in the IFT. The F-14 does not provide a suitable medium for storing trainee data. Without storing trainee data on some storage medium, it is not possible to download the trainee data at an alternate site at the unit or the debrief center. Scenarios are preprogrammed and cannot be modified without a major system software update.

Automated Training Features. The F-14 IFT provides hit-and-miss performance data for the crew, but no real meaningful performance data for training feedback is presented. Scenario dynamics and operator performance is not recorded for scenario reconstruction. Performance measurement is limited to the number of properly engaged targets or improperly engaged targets. These data are not meaningful for training purposes. The F-14 does not have a printer, but if the data were recorded on a magnetic tape cartridge, performance data could be printed at the debrief site.

Scenario Control Features. The IFT uses preprogrammed scenarios which, once started, cannot be frozen with a scenario freeze option nor started at various points in the scenario. Also, without the recorded scenario data, there is no replay capability in the F-14 or at the debrief site.

Instructional Features. The F-14 is not equipped with a demonstration mode or a user-help facility. The IFT is so simple in its present form that neither of these features would appear necessary.

ET/System Coordination Features. The IFT is software integrated into the F-14 electronic equipment. No special equipment is needed for training with the IFT. The IFT is an on-line training device that stimulates the actual radar, IFF, ECM, and ECCM equipment. The IFT cannot send simulated targets over the communications net for coordinated training with other units.

Factors Affecting Training with ET

Logistical Impact Factors. Having the IFT in the F-14 has not increased the number of parts, maintenance requirements, or equipment wear. There are no significant differences between the actual weapon system operation and the IFT equipment. The simulation fidelity is good and simulated targets present no noticeable differences from actual targets.

Time Impact Factors. The F-14 is a highly reliable aircraft, with no significant equipment failures leading to extended system down times. The crew members and the aircraft are always available for training, within the normal operational constraints and unit duties. The IFT was developed during F-14A development. The only significant design problem has been the available memory space for IFT programs. The IFT was engineered with a minimal amount of memory space and no extra memory for future expansions. This limits the number of scenarios that may be stored in the IFT memory (and their complexity).

Operating Impact Factors. Starting the IFT scenario is not extremely difficult, but it does require both the pilot and the RIO to actuate switches. This is not seen as having a serious impact on training with the IFT, but it is more cumbersome than requiring one switch activation by one crew member. Shutting off the IFT only requires one switch action. The F-14 is a highly sophisticated aircraft, which requires extensive training to qualify both crewmen. Sustaining these skills and knowledges requires continual training at the unit and in the air. Operating the IFT is very simple, requiring minimal effort on the part of the crew members. The IFT initializes and shuts down almost instantly.

ET Training Functions

Task Categories. The IFT is used for "switchology" training in individual aircraft. This places it in the "equipment operation training" category. It also provides training for the team tasks between the RIO and pilot but not those among the crew members of different aircraft. The IFT does not provide maintenance training.

Training Uses. The IFT is normally used for individual training of each crew member and team training of both crew members. The IFT trains some of the critical operating tasks in the F-14, but not all. It is useful for sustaining those task skills during normally scheduled training and during preparatory exercises. The IFT is not used for readiness evaluation.

Training Types. The IFT does not train all of the critical mission tasks and skills that the crew members need to sustain after leaving school. Skills such as air-to-air gunnery (with the gatling gun) cannot be trained by the IFT. This classifies the IFT as a part-mission-scenario training device. The IFT is not used for part-task training.

Training Levels. The IFT provides sustainment training of those switch operation tasks that are not capable of being trained in any other way within the units. The available memory limits the IFT scenarios to basic encounters, with no full-mastery-level scenarios. All initial training is provided at the schools.

APPENDIX H

CG-47 AEGIS WEAPON SYSTEM
AEGIS COMBAT TRAINING SYSTEM (ACTS)

AEGIS COMBAT TRAINING SYSTEM (ACTS)

The Aegis system is a centrally controlled array of weapon systems consisting of sonar, radar, and various weaponry. The Aegis system is currently deployed on board the CG-47 class cruisers and is designated to be deployed on board the DDG-51 class destroyers. The highly-sophisticated centralized computer system correlates the target information from the different sensors and automatically accomplishes inter-tactical communications. The CG-47 class cruiser performs the following missions:

1. Anti-Air Warfare (AAW) against aircraft and missiles.
2. Surface Warfare (SUW).
3. Anti-Submarine Warfare (ASW).
4. Support and control of airborne aircraft.
5. Patrol, evacuation, blockage, visit and search, surveillance.
6. Search and rescue.
7. Hydrographic and oceanographic data collection.
8. Support of unit, group, or force operations.

Figure H-1 on the following page illustrates the primary weapon systems and their locations on the CG-47 class cruisers.

The Combat Information Center (CI) is the location of the sensor and weapons control stations. The weapon control station operators, controllers, and supervisors in the CIC include the following:

1. AAWC - Anti-Air Warfare Coordinator.
2. ACS - Air Control Supervisor.
3. AIC - Air Intercept Controller.
4. ARC - Air Radar Controller.
5. ASAC - Anti-Submarine Warfare Air Controller.
6. CO - Commanding Officer.
7. CSC - Combat System Coordinator.
8. DMC - Data Management Console operator.
9. EPC - Engagement Planning Console operator.
10. EWCO - Electronic Warfare Console Operator.

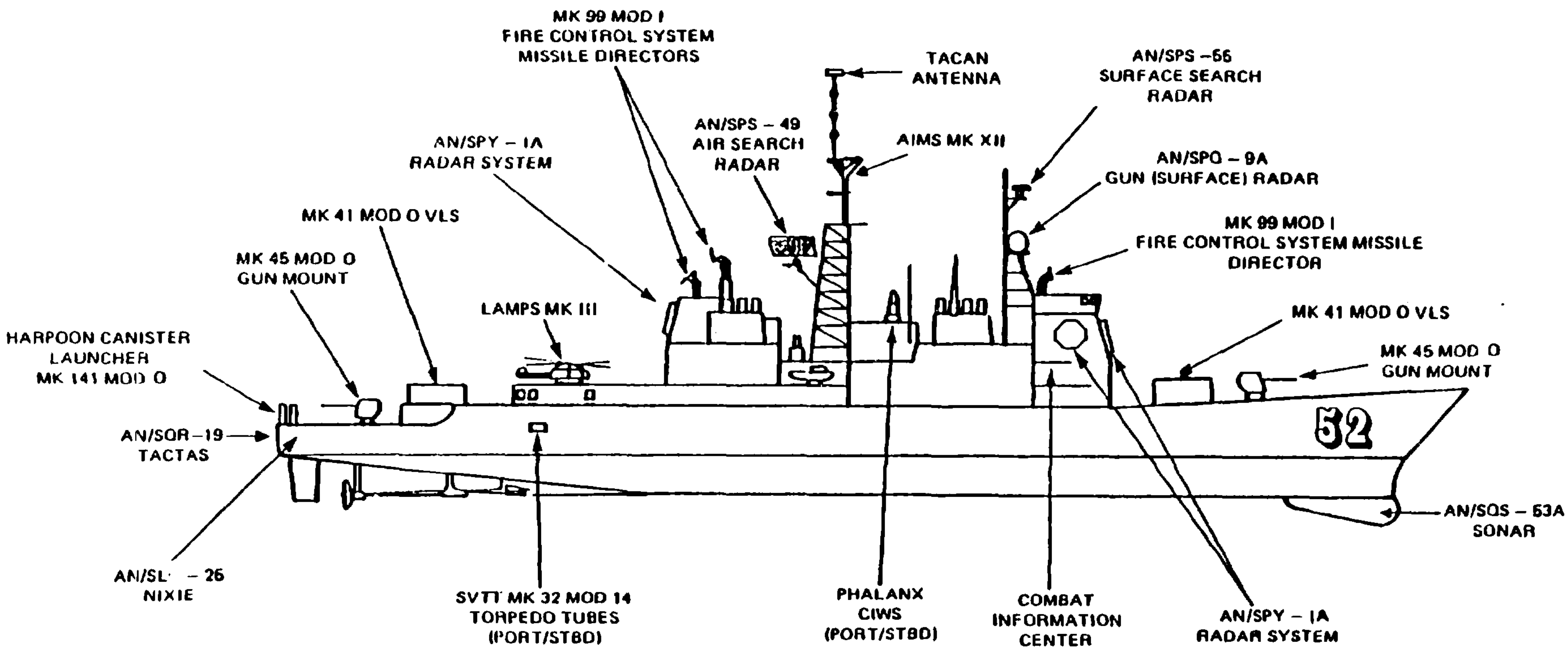


Figure H-1. CG-47 Class Cruiser Primary Weapon Systems and Locations

11. EWS - Electronic Warfare Supervisor.

12. FC - Fire Control system operator.

13. GCCO - Gun Control Console Operator.

14. GFCSS - Gun Fire Control System Supervisor.

15. IDS - Identification Supervisor.

16. LCC - Launch Control Console operator.

17. MSS - Missile System Supervisor.

18. RSC - Radar Set Console/Radar System Controller.

19. SRC - Surface Radar Controller.

20. SSWC - Surface/Strike Warfare Coordinator.

21. TAO - Tactical Action Officer.

22. TIC - Tactical Information Coordinator.

23. UBS - Underwater Battery Supervisor.

The weapon system station locations in the CIC are presented in Figure H-2 on the following page.

Component Descriptions

Anti-Air Warfare Systems. The CG-47 class cruiser is equipped with a large number of AAW systems and subsystems that are controlled by station operators or the Aegis system. The AAW systems on the CG-47 class cruisers include the following:

1. Aegis Weapon System MK 7 Mod 3.

    a. AN/SPY-1A Radar System.
    b. Command and Decision System (C&D).
    c. Weapon Control System (WCS) MK 1 Mod 0.
    d. Fire Control System (FCS) MK 99 Mod 1.
    e. Operational Readiness Test System (ORTS) MK 1.
    f. Aegis Combat Training System (ACTS).

2. AN/SPS-49(V)1 Air Search Radar System.

3. AN/SPS-55 Surface Search Radar System.

4. AIMS MK XII Identification Friend or Foe (IFF) System.

5. Decoy Launching System (DLS) MK 36.

6. AN/SLQ-32(V)3 Countermeasures Set.

7. PHALANX Close-in Weapon System (CIWS) MK 15 Mod 2.

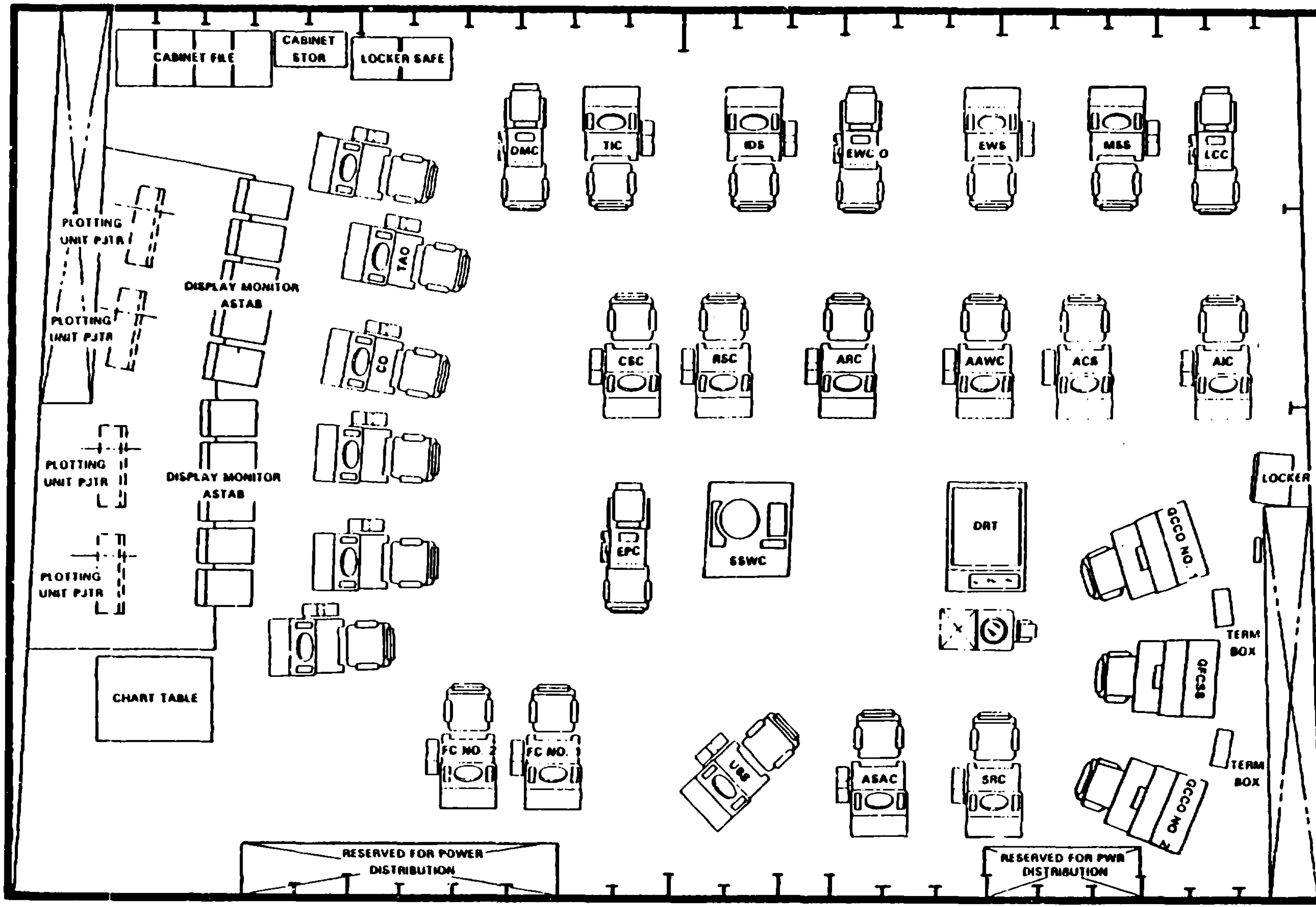


Figure H-2. CIC Weapon System Control Stations

8. Vertical Launching System (VLS) MK 141 Mod (), first installation on CG-52.

9. Gun Fire Control System (GFCS) MK 86 Mod 9.

10. Gun Mount MK 45 Mod 0.

Surface Warfare Systems. The CG-47 Aegis Combat System has numerous systems and subsystems, some which are shared with AAW equipment. The SUW systems on the CG-47 class cruisers include the following:

1. AN/SPY-1A Radar System.
2. AN/SPS-55 Surface Search Radar System.
3. Command and Decision System (C&D).
4. Weapon Control System (WCS) MK 1 Mod 0.
5. Fire Control System (FCS) MK 99 Mod 1.
6. TOMAHAWK Weapons System EX 32 Mod ().
7. Gun Fire Control System (GFCS) MK 86 Mod 9.
8. Gun Mount MK 45 Mod 0.

Anti-Submarine Warfare Systems. The CG-47 class cruiser is equipped to perform ASW autonomously or in conjunction with other ASW units. Some of the ASW systems are shared with AAW and SUW systems. The ASW systems on the CG-47 class cruisers include the following:

1. Command and Decision System (C&D).

2. Weapon Control System (WCS) MK 1 Mod 0.

3. AN/SQS-53A Sonar.

4. AN/SQR-19 Tactical Towed Array Sonar (TACTAS).

5. AN/SQQ-28(V)2 Sonar (LAMPS MK III) Signal Processing System.

6. AN/UYQ-25 Sonar In-Situ Mode Assessment System (SIMAS).

7. Anti-Submarine Warfare Control System (ASWCS) MK 116 Mod 0.

8. Surface Vessel Torpedo Tubes (SVTT) MK 32 Mod 14.

9. AN/SLQ-25 Torpedo Countermeasures Transmitting Set (NIXIE).

ET Component. ACTS is software resident in the Aegis central computer which provides an on-line shipboard coordinated proficiency training capability. ACTS provides the following capabilities:

1. Operator modifiable scenarios.
2. The ability to train on selected combat system elements.
3. Simulations that provide realistic environments.
4. Support for recording data for evaluation.

ACTS trains the operators of the following weapon systems:

1. Command and Decision (C&D) System MK 1.
2. Weapons Control System (WCS) MK 1 Mod 0.
3. Fire Control System (FCS) MK 99 Mod 1.

ET Training Features

Computer-Oriented Features. ACTS does not have a CAI capability. The CG-47 class cruiser does provide a suitable environment for CAI with multiple user stations and comfortable knowledge training atmosphere in CIC. ACTS does not use computer-generated imagery or AI.

Training Management Features. ACTS has a scenario authoring capability and a library of scenarios stored in the computers. Scenarios are modifiable when running. ACTS scenarios can provide evasive targets for training although this is not the same as automated adaptive training (a feature ACTS does not have). There is no built-in recordkeeping although the CIC is a suitable site for maintaining trainee records.

Automated Training Features. ACTS has a performance recording feature which records scenario dynamics and operator responses. This can be printed out for detailed analysis after running the scenario. ACTS does not provide feedback to the operators or measure operator performance. Performance measurement is based on an evaluation of the recorded scenario and operator data and by an over-the-shoulder observation by a training officer.

Scenario Control Features. ACTS has a scenario replay capability using the recorded scenario data. Playbacks assist the training manager in providing detailed corrective and supportive feedback to the trainees. There is no scenario freeze or scenario fast-forward feature.

Instructional Features. ACTS does not have a demonstration mode which would be useful for a training officer to illustrate advanced equipment operations and tactical decision making. There is no user-help facility which could be useful to both the training officer operating ACTS.

ET/System Coordination Features. ACTS is fully integral to the Aegis Combat System. ACTS is capable of being run in either off-line or on-line modes. Specific stations can be selected for training while the other stations continue to operate normally. ACTS can send simulated targets on the communications net for training with participating units.

ET Impact Factors

Logistical Impact Factors. Including ACTS in the Aegis Combat System did not significantly increase the number of parts in the system or the maintenance requirements for the system. ACTS has not increased equipment wear. There are no differences between the ACTS equipment and the Aegis Combat System equipment. ACTS simulates the environment with no noticeable artificial target characteristics.

Time Impact Factors. Aegis is highly reliable and neither ACTS nor Aegis have had significant system failures. Trainees are always available for training while standing watch in the CIC. ACTS is always available within normal operational constraints. ACTS was developed during the development of the Aegis Combat System.

Operating Impact Factors. ACTS is easy to initialize and shutdown, requiring one switch action. The Weapon system, as a whole, is highly complex with many operators, systems, and subsystems interfacing. Aegis coordinates most of these activities making the operators' tasks less numerous. This classifies the Aegis Combat System with a moderate difficulty level of system operation. ACTS is menu driven and extremely simple to operate resulting in an easy operating level. Starting up the ACTS takes approximately five minutes while shutdown takes less than one minute.

Training Functions for ET

Task Categories. ACTS trains equipment operation tasks and some coordinated tasks between operators and other units. ACTS stimulates equipment at the tactical decision level and not at the sensor station level. There are separate sensor station stimulators which are not a part of ACTS. No maintenance training capabilities are provided by ACTS.

Training Use. ACTS is used to train operators of the following equipment:

1. Command and Decision (C&D) System MK 1.
2. Weapons Control System (WCS) MK 1 Mod 0.
3. Fire Control System (FCS) MK 99 Mod 1.

These operators are trained individually and as teams. ACTS is used for preparatory exercises and readiness evaluations prior to deployment.

Types of Training. ACTS provides a full-mission scenario capability as well as a part-mission scenario capability. This only depends on the scenario authored. ACTS could be used for part-task training but is not normally used for that purpose.

Training Levels. ACTS scenarios are used for initial training of Aegis Combat System skills, sustainment training, and development of those skills to full mastery. There is currently no school for the Aegis system, so Aegis specific skills are trained upon the operator's arrival to the ship.

APPENDIX I

DDG-993 COMBAT SYSTEM
COMBAT SIMULATION TEST SYSTEM (CSTS)

DDG-993 COMBAT SIMULATION TEST SYSTEM (CSTS)

The DDG-993 is a guided missile destroyer capable of subsurface, surface, and surface-to-air warfare. The combat system is computerized, with central control of sensors and weapon systems taking place in the Combat Information Center (CIC). The sensors are primarily radar and sonar. The DDG-993 missions include the following:

1. Conduct and coordinate Anti-Air Warfare (AAW) against aircraft and missiles.
2. Conduct and coordinate Anti-Submarine Warfare (ASW) operations.
3. Conduct and coordinate Surface Warfare (SUW) operations.

The DDG-993 class destroyers have many sensors and weapons. Figure I-1 shows the primary weapon systems and their locations on a DDG-993 class destroyer. Most of these weapons and sensors are controlled from weapon system stations located in the CIC. The weapon system station controllers, operators, and supervisors in the CIC include the following:

1. AAWC - Anti-Air Warfare Coordinator.
2. AD/T - Air Director/Tracker.
3. AIC - Air Intercept Controller.
4. ASAC - Anti-Submarine Warfare Air Controller.
5. ASWCSO - Anti-Submarine Warfare Control System Operator.
6. ATACO - Air Tactical Control Officer.
7. BVP D/T - Beacon Video Processor Director/Tracker.
8. CO - Commanding Officer.
9. D/TM - Director/Tracker Monitor.
10. DMC - Data Management Console operator.
11. EPC - Engagement Planning Console operator.
12. EWO - Electronic Warfare Officer.
13. GCC - Gun Control Console operator.
14. GCOC - Gun Control Officer's Console.

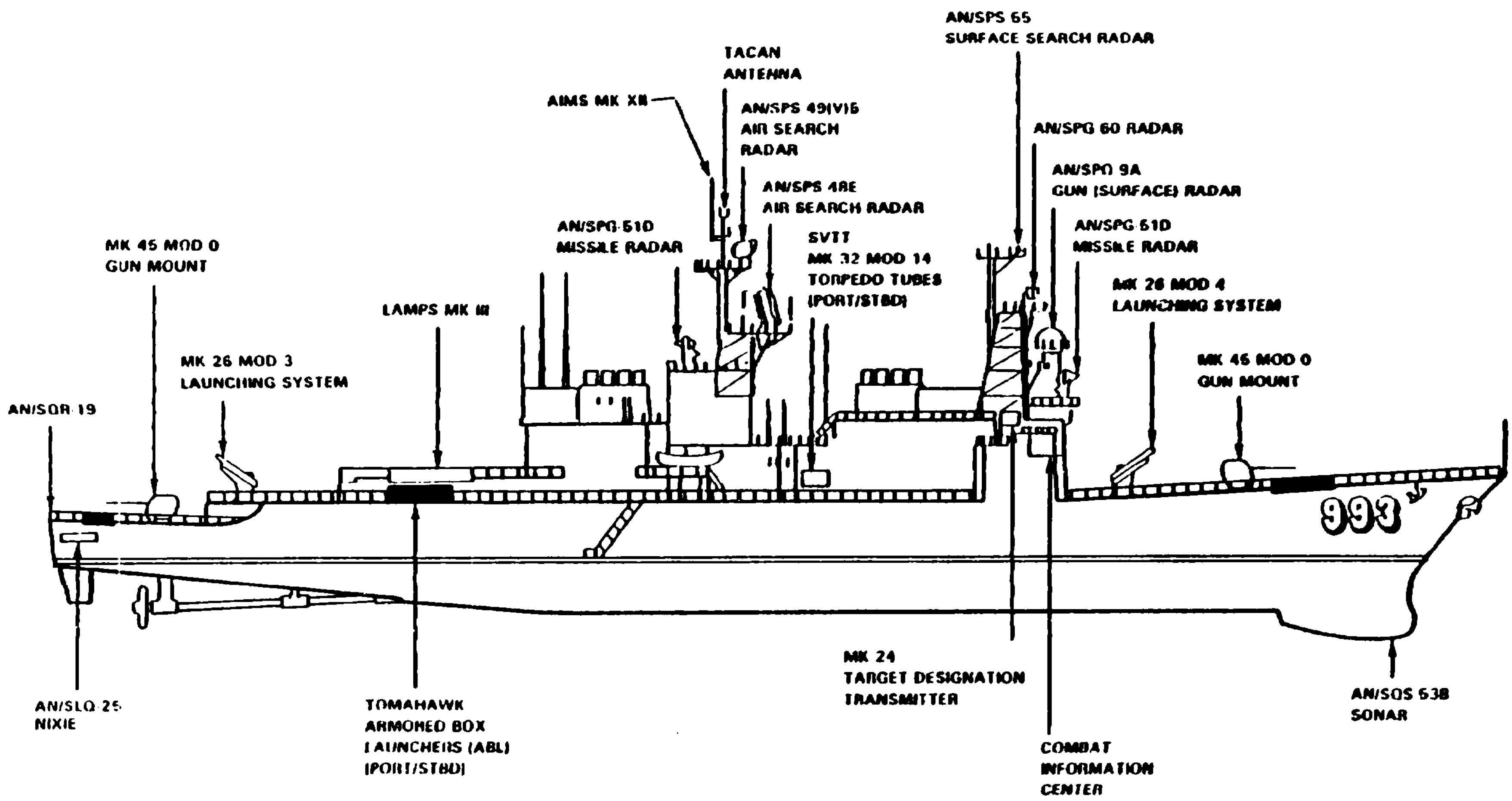


Figure I-1. DDG-993 Class Destroyer Primary Weapon System Locations

15. ID - Identification operator.

16. MEC - Missile Engagement Controller.

17. RADIO MON - Radio Monitor.

18. RCO - Radar Control Operator.

19. RSCO - AN/SPS-48E Radar Set Control Operator.

20. SLQ-32 OPR - AN/SLQ-32 Electronic Warfare Operator.

21. SQQ-28 - AN/SQQ-28(V)2 SONAR (LAMPS MK 111) Signal Processing System Operator.

22. SQR-19 - AN/SQR-19 Tactical Towed Array Sonar (TACTAS) operator.

23. SQS-53 - AN/SQS-53B SONAR operator.

24. SSTWC - Surface/Strike Warfare Coordinator.

25. SURF D/T - Surface Detector/Tracker.

26. TAO - Tactical Action Officer.

27. TRK SUP - Track Supervisor.

28. WCC - Weapons Control Console operator.

29. WCP - Weapons Control Panel operator.

30. WEC - Weapons Engagement Coordinator.

The locations of the weapon system stations and other equipment in the CIC are shown in Figure I-2 on the following page.

Component Descriptions

Anti-Air Warfare Systems. The AAW systems are integrated to permit the implementation of command doctrine; to detect targets and determine threats; to disseminate tactical information; to provide for the allocation, assignment, and control of weapons for the engagement of air threats; and to assess engagement results. The equipment used in the AAW tasks is as follows:

1. AN/SPS-48E 3-D air search radar.

2. AN/SPS-49(V)5 long-range air search radar.

3. AN/SPS-55 surface search radar.

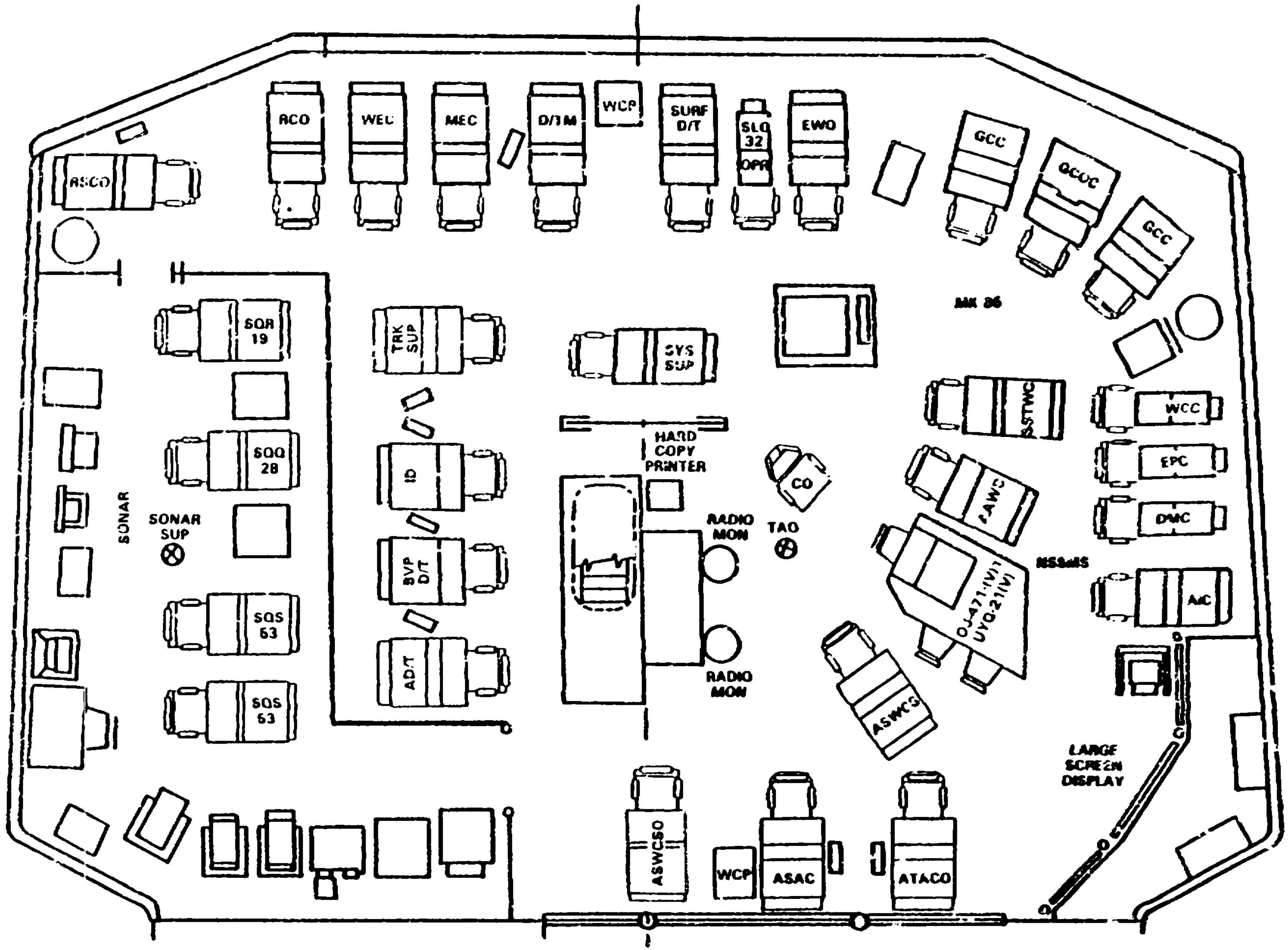


Figure I-2. DDG-993 Combat Information Center

4. AN/SYS-2 integrated automatic detection and tracking (IADT) system.

5. AIMS MK XII identification-friend-or-foe (IFF) system.

6. AN/SLQ-32(V)3 countermeasures set.

7. Decoy launching system (DLS) MK 36.

8. Combat direction system (CDS), with the Naval Tactical Data System (NTDS New Threat Upgrade (NTU).

9. Weapons Direction System (WDS) MK 14.

10. AN/SYR-1 communications tracking set.

11. Signal Data Converter (SDC) MK 72.

12. Missile Fire Control System (MFCS) MK 74.

13. Gun Fire Control System (GFCS) MK 86.

14. Inertial Navigation Set (INS) AN/WSN-5.

15. Guided Missile Launching System (GMLS) MK 26.

16. Gun mount MK 45.

Surface and Strike Warfare Systems. The SUW and strike warfare equipment has some commonalities with AAW equipment. The SUW equipment is used for defending against enemy surface vessels, and the strike equipment is used for attacking enemy positions ashore. The SUW and strike equipment include the following:

1. AN/SPS-55 surface search radar.

2. OUTBOARD Tactical Signals Exploitation (TSE) system.

3. TOMAHAWK weapon system EX 32.

4. Gun Fire Control System (GFCS) MK 86.

5. Target Designation Transmitter (TDT) MK 24 and Control Unit (CU) MK 79 Mod 7.

6. Gun mount MK 45.

Anti-Submarine Warfare Systems. A DDG-993 class destroyer is equipped with a vast array of ASW systems and weaponry. It is capable of defending itself and its task force against enemy submarines. It uses its own sensors and coordinates the sensing activities of ASW aircraft. Its compliment of ASW weapon systems includes a Lamps MK III

ASW helicopter. The ASW systems employed on a DDG-993 class destroyer include the following:

1. AN/SQS-53B sonar.
2. AN/SQR-19 Tactical Towed Array Sonar (TACTAS).
3. AN/SQQ-28(V)2 Sonar (Lamps MK III) Signal Processing System (SSPS).
4. AN/UYQ-25 Sonar IN-SITU Mode Assessment System (SSPS).
5. Anti-Submarine Warfare Control System (ASWCS) MK 116.
6. Anti-Submarine Rocket (ASROC) launcher system MK 16.
7. Surface Vessel Torpedo Tubes (SVTT) MK 32.
8. AN/SLQ-25 Torpedo Countermeasures Transmitting Set (NIXIE).

ET Component. The CSTS is a dual-purpose system, with specially integrated hardware and software. Originally, CSTS was developed as a strap-on system (then called the Combat System Test Set). Now, in its second generation, each ship has a CSTS (now called the Combat Simulation Test System) integrated within the ship. The hardware specific to the CSTS includes several general-purpose computers and a Test Control Console (TCC), which serves as the instructor station. The ship's combat system must be in the normal operating mode prior to starting the CSTS. In addition to the simulation capability for training, the CSTS also provides a test function for testing the various sensor station displays and weapon system equipment.

The systems presently tied to the CSTS include the command and decision system (C&D), the radio communications system (RCS), the surveillance and AIMS system (SAS), the gun fire control system (GFCS), the missile fire control system (MFCS), the underwater fire control system (UFCS), and the ships log and gyro system. The CSTS provides simulated targets for presentation on the ship's radar and sonar displays. The sonar targets are active targets because the CSTS is capable of stimulating the passive acoustic sensors. The CSTS also provides information about the ship's course, speed, pitch, and roll, in order to simulate a realistic combat environment.

The CSTS uses either preprogrammed scenarios (stored on magnetic disk) or scripted scenarios that require the training coordinator to enter the data according to a defined time line. The CSTS provides training for operators in the CIC, including sonar, radar, and tactical operators.

ET Training Features

Computer-Oriented Features. The CSTS does not have a CAI capability. The CIC would be a suitable environment for a CAI presentation. The CSTS does not use AI or have computer-generated imagery.

Training Management Features. Scenarios may be authored, using the TCC and storing them on the magnetic disk drive. Scripted scenarios can be run from the TCC. Also, the training manager can modify and enter scenario data while the scenario is running. CSTS does not have automated adaptive training nor a built-in recordkeeping capability.

Automated Training Features. The CSTS does not have any automated performance measures. There is no performance feedback, performance measuring, or report generation capabilities. It is possible to use the NTDS to data extract mission data, and then to compare it with known scenario target tracks. The only other performance recording possible, is the record made by the training manager during over-the-shoulder observations.

Scenario Control Features. The CSTS does not have a scenario freeze or fast-forward feature. Since no data is recorded, there is no scenario playback capability.

Instructional Features. The CSTS does not have a demonstration mode or user-help facility. On a system as complex and teamwork-oriented as the DDG-993 combat system, a demonstration mode would be useful to the training manager, for showing advanced equipment-operation techniques and team operations techniques to the CIC operators. The CSTS is mostly menu driven and easy to operate, which indicates that a user-help facility is not necessary.

ET/System Coordination Features. Although the CSTS has its own instructor station and special electronic components, all of it is integrated into the CIC. This classifies it as an integral training system. It is important to note that the first-generation CSTS was a strap-on system that was stationed at pier side, with cables that were hooked to the CIC systems. The CSTS can be operated at sea or at pier side in its present integrated form; however, operating the CSTS inhibits the CIC stations selected for training from performing any operational functions. Part of the CSTS is a "link 4/11" simulator, which simulates friendly and non-friendly positions on the link 4 and link 11 communications networks. This is only simulated on the CIC link 4 and link 11 display consoles; it is not networked to other participating units.

Factors Affecting Training with ET

Logistical Impact Factors. The CSTS has several major pieces of equipment that have been added specifically for CSTS operation. The addition of this equipment has significantly increased the number of parts needed in the inventories of the DDG-993 class destroyers. With the addition of this equipment, the maintenance responsibilities have been increased. It is important to note that the CSTS has a testing mode which aids in the maintenance of the operational equipment. No additional wear caused by the presence of the CSTS has been identified. There are significant differences between the CSTS TCC and the weapon system operating stations. The TCC has four color monitors with touch screens. The weapon system control stations have only monochrome monitors, with keyboards and special-function keys.

Time Impact Factors. The CIC weapon systems and equipment are very reliable, with no significant equipment failures causing extended system down-times. CSTS is also very reliable with no problems with system down-time. The CSTS is always available for training, as long as its use does not interfere with the operational needs of the ship. Since specific stations can be selected for simulation, training is easy to schedule both at sea and in port. Trainees are always available, within the constraints of their regular assigned duties. The CSTS was developed as a test set after development and design of the DDG-993 class destroyer. Later the CSTS was developed into its present form, as a training and testing system. This type of development is believed to be very costly, although no specific cost data are available.

Operating Impact Factors. The CSTS has five switches for initiating and stopping the training mode. It also requires some data entry (for setup) prior to running a scenario. All systems in the CIC must be up and operationally configured before the CSTS is started. These requirements give the system a medium difficulty level rating for start-up and shutdown. The weapon systems are fairly complicated, with a central control and automated processing of target data in the CIC. The weapon system has been given a medium difficulty level for operation. The CSTS is, by itself, a simple system to operate, but start-up and shutdown times are over one minute.

ET Training Functions

Task Categories. The CSTS stimulates several weapon systems in the CIC, while providing equipment operation task training. It also provides team system-operating training when multiple weapon system stations are stimulated at the same time. The CSTS has a testing mode that aids maintenance personnel, but it does not train maintenance tasks.

Training Uses. The CSTS is used for individual training, team training, and preparatory exercises. When an individual operator station in the CIC is selected for training, the CSTS is used for individual training. Also, several different weapon system operators can be given team training at the same time. The CSTS is also used prior to readiness exercises, to improve the ship's fighting performance and to prepare for the predeployment evaluations. The CSTS is not presently used during these readiness exercises.

Training Types. The CSTS is capable of running full- or part-mission scenarios from the magnetic disk cartridge. Scenarios can also be run based on a written script with the training manager entering scenario data. The CSTS is not used for part-task training.

Training Levels. The CSTS provides initial training for newly arriving operators. One of the reasons the CSTS was developed into its current form was to fulfill the training and personnel requirements that the shore-based schools could not provide. The CSTS is capable of training operators to the full-mastery level if challenging scenarios are authored.

APPENDIX J

PROGRAM MANAGER DATA GATHERING FORM

PROGRAM MANAGER DATA GATHERING FORM

Date: ______________

1. System Name ______________________________ Device # __________

2. Service Branch: Navy _____ Air Force _____ Army _____ (Check One)

3. Command ______________________________ (Unit Name)

4. Location ______________________ (Base) __________ (State)

5. Brief description of weapon system function ____________________

____

Development History

6. How did the embedded training system enter the life cycle of the prime equipment?

____

____

____

7. How were embedded training requirements derived?

____

____

____

8. What type of equipment constraints did prime equipment have to overcome to include embedded training? (i.e., hardware, software, etc.)

____

____

9. How were embedded training components integrated into the weapons system?

_____ Strapped on

_____ Integrated into operational hardware/software

Other ____

____

10. List the major hardware interface components of the prime weapon system which has embedded training (include display, control/indicator groups):

_______________ _______________ _______________

_______________ _______________ _______________

_______________ _______________ _______________

11. Is commercial hardware/software used in the embedded training (ET)?

YES NO

12. What type(s) of embedded training tasks take(s) place on the system? (Check/fill-in)

____ Operations ____ Maintenance ____ Team

Other (specify) ______________________________

13. What types of tasks and task elements are taught using embedded training? (Check/fill-in)

_____ Basic Manipulative Skills _____ Set Procedures (invariant)

_____ Variable Procedures _____ Knowledges

_____ Rule or Concept Use _____ Multiple Skills (performances)

Other ______________________________

14. Does embedded training system capacity (computing) support training requirements? If not, explain what is additionally needed.

____

____

15. How long has embedded training system been operational?

__________ Months/years

16. How was training performed prior to embedded training?

____

____

17. To what extent did human factors analysis enter into the embedded training development?

____

____

18. Types of media or technology is used for embedded training. (Check/fill-in)

_____ CAI _____ Artificial Intelligence

_____ Voice Synthesis _____ Recorded Voice

_____ Videodisc _____ Slides

_____ Computer Generated Graphics _____ Read/Write Video Systems

Other ____

____

19. Instructional features of embedded training system. (Check/fill-in)

_____ Freeze _____ Playback

_____ Fast/Slow Action _____ Help (remediation)

_____ Performance Analysis

_____ Adaptive (does system sense performance level and adapt to individual)

Other ____

20. Is there a difference between what the operator sees during embedded training and normal operations?

YES NO (If YES, explain below)

____

____

<u>Description of Typical Embedded Training Scenario</u> (Questions 21, 22, 23)

21. Set-up time _____ minutes

22. Environment _______ (actual/simulated)

23. Time required to switch from operational to embedded training ____/____ (minutes/seconds)

24. Time required to switch from embeded training to operational ____/____ (minutes/seconds)

25. Difficulty in going from training to operational mode. (Check one)

_____ Very Difficult _____ Difficult

_____ Fairly Easy _____ Very Easy

26. What other types of training (besides embedded training) support this weapons system? (Check/fill-in)

_____ Classroom instruction _____ OJT _____ CAI

Other ____

27. Were prime system subject matter experts available for training requirements analysis during embedded training development?

    YES   NO   (circle one)

    What was the assumed entry level of the embedded training system user? (Questions 28, 29, 30)

28. _____ Pay Grade (i.e., Lt, E-5, etc.)

29. _____ Specialty

30. _____ Experience level (yrs. operating same or similar equipment)

31. Who actually ended up using the embedded training system? (Check/fill-in)

    _____ Primary systems operators/maintainers

    _____ Operators/maintainers-under-training (not qualified)

    Other ______________________________

32. What types of supporting training materials were delivered with the embedded training program? (manuals, student workbooks, lesson guides, system and instructional evaluation forms, etc.) (List)

    ____________ ____________ ____________

    ____________ ____________ ____________

33. Does the system require instructor intervention?

    YES   NO

34. Was the embedded training program seen as being useful by the user?

    YES   NO

35. Did the user resist the incorporation of embedded training (including hardware/software/courseware)?

    YES   NO

36. Has feedback from the user resulted in any modifications in the original embedded training configuration?

    YES   NO   (If YES, explain)

    ____

    ____

37. How would you modify the existing embedded training program to improve it?

____

____

____

____

38. What was the overall cost of the embedded training package? (If known)

_____ Original estimate $ _____ Final $

APPENDIX K

TRAINING MANAGEMENT DATA GATHERING FORM

TRAINING MANAGEMENT DATA GATHERING FORM

Date: ______________

1. System Name ______________________________ Device # ____________

2. Service Branch: Navy _____ Air Force _____ Army _____ (Check One)

3. Command ______________________________________ (Unit Name)

4. Location ____________________________ (Base) ____________ (State)

5. Brief description of weapon system function ____________________

____

____

____

6. At what point was the user introduced to the embedded training program? (check/fill in)

_____ During system development _____ During acceptance testing

_____ After system delivery Other ________________________

7. Where did embedded training enter the weapons systems life cycle? (check/fill in)

_____ Developed in parallel with the evolving weapons system

_____ Added on at a point during system design, (where) __________

____

_____ Added on after system was operational (when) _______________,

(why) ____

8. How were embedded training components integrated into weapons system?

_____ Strapped on

_____ Integrated into operational hardware/software

Other ____

9. Who were the first people exposed to embedded training? (in your command)

_____ Training Managers _____ Subject Matter Experts (intended users)

_____ Software/Hardware/Courseware maintenance personnel

Other ____

10. What types of support documentation and training materials were delivered with the embedded training program?

____ Instructor Guides ____ Student Guides/Workbooks

____ Scenario Guides ____ Off-line CAI Training

Other ____

____

11. What types of tasks and task elements are taught/practiced using the embedded training program?

____ Variable procedures ____ Set procedures (invariant)

____ Basic manipulative skills ____ Knowledges

____ Rule or concepts ____ Multiple skills (performances)

Other ____

____

12. Does the embedded training system require addition of displays/controls?

YES NO (If YES, explain) ______________________________

____

13. What limitations did the prime equipment place on the embedded training program? (i.e., memory capacity, hardware, etc.)

____

____

____

14. How were training tasks taught prior to embedded training? (specify) (i.e., institutionalized, OJT, Operator Schools, etc.)

____

____

15. Who maintains the embedded training courseware materials? (specify) (i.e., testing materials)

____

____

16. Who maintains the hardware/software? (At the unit or sent out) (specify)

____

____

17. Is commercial embedded training hardware/software available?

YES NO

18. What is the mean-time-between-failure for the embedded training system?

____

19. What was the advertised mean-time-between-failure? ____________

20. How long has the embedded training system been in place?

__________ (Months/years)

21. What unique training opportunities does the embedded training system provide? (i.e., practice with seldom seen targets, etc.) (specify)

____

____

____

22. Does the embedded training system overtax the operational system?

YES NO (if YES, in what way are the consequences apparent?)

____

____

23. What are the benefits of embedded training versus conventional training? (please be specific)

____

____

24. Do you feel more comfortable in a battle situation with personnel who have been trained using embedded training

YES NO

25. Do personnel using embedded training reach operator proficiency more rapidly than those trained by conventional means?

YES NO (if NO, why do you think that is?) ____________

____

26. How is embedded training scheduled? ____________________

____

27. What is the priority for embedded training? ____________________

____

28. What is the availability of the operational systems for embedded training? ____

____

29. What is the availability of personnel to use embedded training?

____

____

30. What is the average usage of the embedded training system per month?

_____ Hours/per person

31. What types of training take place on the embedded training system? (specify)

_____ Operations Tasks _____ Maintenance Tasks _____ Team Tasks

32. Have any students with no previous formal training used the embedded training system?

YES NO

33. Refer to Question 32. _____ How Many?

34. Refer to Question 32. What type of training did they receive?

____

35. How are the results of embedded trianing segments evaluated?

____

____

36. Is the embedded training system tied to any proficiency or qualification?

YES NO (If YES, specify) ____________________________

____

37. Has embedded training resulted in any "negative transfer of training?

YES NO (If YES, specify) ____________________________

____

38. Is the embedded training system updated as the weapons system changes?

YES   NO

(If YES, who causes the update; who determines new training requirements) ____

____

39. Were additional command staff required to maintain an embedded training system?

YES   NO

40. Who is the embedded training data reported to?

_____ No one   _____ Training Officer

_____ Command only   _____ Higher authority

41. What problems do you perceive in the present embedded training system, and what could be done to solve them?

____

____

____

____

____

APPENDIX L

TRAINEE DATA GATHERING FORM

TRAINEE DATA GATHERING FORM

Date: ______________

1. System Name ____________________________ Device # ____________

2. Service Branch: Navy _____ Air Force _____ Army _____ (Check One)

3. Command ____________________________________ (Unit Name)

4. Location __________________________ (Base) __________ (State)

5. Pay Grade _____ Specialty _______________ (i.e., radar, communications)

6. Position __________________________ Time in military _______

7. Previous experience with computer based training systems.

   YES NO

8. Civilian Education (check highest level)

   ___ Some High School ___ High School Grad ___ Technical School Grad

   ___ AA/AS ___ BS/BA ___ MS/MA ___ PhD

9. Approximately how much training have you received on your present embedded training system? (in hours or days) _______________

10. How are you scheduled for training sessions? (Check)

    _____ Posted Schedule (includes POD or Flight Schedule)

    _____ Verbally

    _____ No Formal Schedule

11. When does embedded training normally take place? (e.g., during practice battle problems, during off-hours, etc)

    ____

    ____

12. What is the availability of the embedded training system for training? (Circle appropriate description)

    Never Available   Sometimes Available   Usually Available   Always Available

13. What is your availability for using the embedded training system?

Never Available	Sometimes Available	Usually Available	Always Available

14. How were you trained to utilize the embedded training system? (Check one or more)

____ On the embedded training system

____ Used computer based training

____ Used self-paced written materials

____ Lectures

Other ____________________

15. Describe how you start up the embedded training system (if someone else does it for you, state who that is)

____

____

16. Using the embedded training system is: (circle correct answer)

Extremely Difficult	Very Difficult	Difficult	Easy	Simple

17. How is the weapons system to operate? (circle)

Extremely Difficult	Very Difficult	Difficult	Easy	Simple

18. How is the embedded training system to operate? (circle)

Extremely Difficult	Very Difficult	Difficult	Easy	Simple

19. How does the embedded training system differ from the actual equipment? (i.e., controls, displays, indicators)

____

____

20. Are the training materials presented in a manner which makes them easy to learn from?

YES NO (If NO, explain) ____________________

____

21. Do training lessons guide you to the next action required?

YES NO

22. Will the embedded training program let you enter into the lessonware at different points (can you skip ahead without working all lower level lessons)?

    YES   NO

23. What are the different modes in the embedded training program? (Check)

    _____ Part Task (practice using different functions and controls)

    _____ Computer Aided Instruction (knowledge and procedure which are necessary to perform higher level tasks)

    _____ Full Scenario Training (simulates operational environment)

    _____ Degraded Operations (simulates equipment failures)

    _____ Maintenance Training (for operator and technicians)

24. How long does it take to go from embedded training to the full normal operational mode?

    _____ Seconds/minutes

25. How difficult is it to go from embedded training to the full normal operational mode?

    Extremely Difficult   Very Difficult   Difficult   Easy   Simple

26. Are embedded training lessons tied to your professional qualifications?

    YES   NO

27. Has embedded training helped you gain proficiency in performing your duties?

    Not at all   Rarely   Somewhat   Usually   Always

28. Do you request embedded training from those who schedule its use?

    Never   Rarely   Occasionally   Always

29. Are your embedded equipment training lessons graded?

    YES   NO

30. How is embedded training data gathered ______________________________

31. What form of feedback are you given (debrief, ??) _________________

    ____

32. What, if any, are the consequences for good or bad embedded training performance

____

33. When was the first time you used the equipment training program?

__________ Month/year

34. When was the last time you used the equipment training program?

__________ Month/year

35. Is it possible to damage the operational equipment by using the equipment training program improperly?

YES NO

36. Have you ever had to interrupt training because of a failure in the embedded training hardware/software?

YES NO

37. Does the embedded training system affect the operational equipment in a negative way (wear it out, etc)?

YES NO (If YES, explain) ____________________

____

38. Is it possible to be injured if the embedded training program is not used properly?

YES NO

39. How long is a typical embedded training lesson?

________ Minutes/hours

40. Can the embedded training program be run while the operational system is in its normal operating mode?

YES NO

41. What do you see as the biggest benefit of embedded training?

____

____

____

____

42. What are the embedded training system problems?

____

____

____

____

43. If you had the assets and authority, how would you solve the problems you have listed in Question 42?

APPENDIX M

MAINTAINER DATA GATHERING FORM

MAINTAINER DATA GATHERING FORM

Date: ______________

1. System Name ______________________________ Device # ____________

2. Service Branch: Navy _____ Air Force _____ Army _____ (Check One)

3. Command ______________________________ (Unit Name)

4. Location ______________________ (Base) __________ (State)

5. Brief description of weapon system function

____

6. Who maintains embedded training software/hardware?

____

____

7. How does an embedded training system update take place?

____

____

8. Is there a dedicated group tasked with embedded training updates?

____

9. Is it difficult to cause a needed change in the embedded training package?

   YES NO

10. Are there courseware/software/hardware remarks fed back from the students?

   YES NO

11. Is embedded training used for maintenance training? YES NO

12. Does the embedded training system overburden the supply system with additional parts requirements?

   YES NO

13. Is the embedded training system user friendly? YES NO

14. What problems are perceived with the embedded training system?

____

____

____

15. How would you solve them if you had the assets and authority?

____

____

____

____

____